RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 59 NOVEMBER, 1952 No. 5

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Irradiation Effects of Roentgen Therapy on the Growing Spine

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IN ADMINISTERING roentgen therapy to retroperitoneal or paravertebral neoplasms in children, the radiologist is faced with these two questions: "What possible effects on the growth of the spine may result from the therapy?," and "How can the tumor be irradiated in adequate dosage with minimal damage to the spine?" These were the questions which led to the present study. It consists of a follow-up of 45 patients who received roentgen therapy over the spine. Thirty-four living patients were observed over a period averaging six and a half years. Postmortem examination on 11 patients provided additional material used in the study.

The experimental work concerning the effect of roentgen irradiation on the growth of bone in animals has been presented by Gates and Warren (1), Hinkel (2–4), Barr (5), Reidy (6), Gall (7), and coworkers. They have shown that when an epiphysis was exposed to 600 r or more of x-radiation, some retardation of growth usually occurred. Hinkel found that less than 500 r did not produce detectable stunting. The degree of stunting with higher doses seemed to depend on the age of the animal as well as on the dosage. Maximal effects, or complete inhibition of epiphyseal growth, were produced by 1,200 r or more.

Quantitative relationships between the vulnerability to damage by irradiation of specific tissues in various animal species have not been studied extensively. Until it is shown that similar doses produce similar tissue responses independent of the species, or until a unit is devised which can serve as a common denominator for local tissue effects in all animal forms, effective irradiation dosage in man can only be determined empirically. This was one of the aims of this study. It is noteworthy that, in dogs and rats, severe disturbances of growth were elicited in the long bones by single roentgen treatments with dosages far lower than those delivered to the spine in the patients of this series.

Clinical reports of growth disturbances in children resulting from roentgen irradiation have been infrequent, only 10 well documented reports having been found in the literature (8–17). In these, 16 patients are described in whom disturbances of bone growth occurred following irradiation. For 9 of these the depth dose delivered to the affected epiphysis was either stated or could be estimated from the data given. It ranged between 800 and 5,576 r.

[1] From the Departments of Radiology, Pathology, and Orthopedic Surgery of the Children's Medical Center and Harvard Medical School. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

This study was supported in part by the United States Atomic Energy Commission.

[2] Aided by a grant from the Playtex Park Research Institute.

TABLE I: EFFECTS OF IRRADIATION ON VERTEBRAL DEVELOPMENT IN 34 PATIENTS
(Tabulation of dosage, age at treatment, and deformity in patients still living)

Case	Age at Initiation of Treatment (yr.)	Years Followed After Treatment	Age at Last Follow-up (yr.)	Tissue r to Spine	Therapy Course (days)	Interval Between Courses (yr.)	Irradiation Effects
1	1/12	13 3/12	13 4/12	(a) 580	16	2/12	
				(b) 186	6		
				766			
2	4/12	3 3/12	3 7/12	(a) 287	5	5/12	
				(b) 260	3		
				547			
3	6/12	3 8/12	4 2/12	18	1	..	
4	7/12	6 6/12	7 1/12	(a) 128	1		
				(b) 128	1		No Roentgenographic Abnormality
				256			Total: 13 patients
5	8/12	6 4/12	7	363	4	..	
6	1	3 8/12	4 8/12	408	5	..	
7	1 5/12	11 8/12	13 1/12	600	24	..	
8	2 6/12	10 11/12	13 5/12	1,380	31	..	
9	4 2/12	5 2/12	9 4/12	1,314	23	..	
10	4 4/12	11 3/12	15 7/12	150	18	..	
11	5	5 2/12	10 2/12	650	19	..	
12	5 10/12	7 7/12	13 5/12	1,350	17	..	
13	9 10/12	3 8/12	13 6/12	2,080	29	..	
14	3 3/12	4 1/12	7 4/12	1,856	24	..	
15	3 6/12	4 6/12	8	1,300	10	..	Exostosis
16	4 1/12	2 2/12	6 3/12	(a) 1,510	19		
				(b) 335	10	1/12	
				1,845			
17	5	4 2/12	9 2/12	1,810	24	..	Exostosis
18	6	7 6/12	13 6/12	1,360	22	..	
19	6/12	3 1/12	3 7/12	(a) 1,360	11		Transverse Growth Disturbance Lines (Fig. 1)
				(b) 626	5	2/12	Total: 9 patients
				1,986			
20	11/12	3	3 11/12	(a) 1,300	11	1/12	
				(b) 580	6		
				1,880			
21	1 4/12	6 6/12	7 10/12	1,034	15	..	Exostosis
22	1 8/12	5 6/12	7 2/12	2,670	32	..	
23	3/12	12 9/12	13	1,322	20	..	
24	3/12	10 4/12	10 7/12	(a) 1,245	42	..	Irregular Epiphyseal Line Without Gross Abnormality of Contour (Fig. 3)
				(b) 1,455	14	1/12	Total: 2 patients
				2,700			

Because of the wide variation in dosage, a clear quantitative relationship between degree of stunting and dosage is not apparent. However, several features of these reported cases deserve mention.

1. One child, aged five months, who received a total tissue dose of 800 r showed definite growth retardation confined to the irradiated area. The irradiation was given in three doses, spaced over an eleven-month period, and involved the proximal epiphysis of the femur (14).

2. Regional effects on growth in areas removed from the actual site of irradiation have been reported. In one case (9) there was retardation of growth of the entire pelvis and distal femoral epiphysis after irradiation totaling 1,610 r to the proximal portion of the femur. Similar growth retardation of the phalanges of the thumb occurred in one case (10) where radium therapy was applied at the base (dosage not given).

3. The only reported case (15) in which vertebral effects were noted was that of an infant of nineteen months who received 5,576 r in six months for a Wilms' tumor in the left flank. This was followed by under-development of the left lower extremity, scoliosis, and wedging of the exposed vertebral bodies. The possibility of radiation myelitis or damage by radia-

TABLE I.—*cont.*

Case	Age at Initiation of Treatment (yr.)	Years Followed After Treatment	Age at Last Follow-up (yr.)	Tissue r to Spine	Therapy Course (days)	Interval Between Courses (yr.)	Irradiation Effects
25	3/12	5 8/12	5 11/12	(a) 1,070	22	..	Exostosis
				(b) 1,880	15		
				2,950			
26	5/12	13	13 2/12	2,700	40	..	
27	6/12	4	4 6/12	(a) 1,753	15		
				(b) 1,107	9	2/12	
				(c) 603	8	4/12	
				3,463			
28	1 1/12	2 7/12	3 8/12	(a) 1,112	11		
				(b) 1,382	6	3/12	
				2,494			
29	1 8/12	6 1/12	7 9/12	(a) 1,130	14		
				1,005	8	2/12	
				2,135			
30	9/12	7 9/12	7	(a) 816	8		
				1,632	13	3/12	
				2,448			Abnormal Contour of Vertebrae (Figs. 4 and 5)
31	10/12	7 10/12	8 8/12	(a) 1,949	19		Total: 10 patients
				1,517	9	4/12	
				3,466			
32	1 4/12	7	8 4/12	(a) 1,900	16		Scoliosis
				1,600	12	7/12	
				3,500			
33	4/12	4 9/12	5 1/12	(a) 730	11		Scoliosis
				578	8	1/12	and
				462	8	4/12	Exostosis
				760	8	2/12	
				2,530			
34	4/12	3 8/12	3 11/12	(a) 2,726	24		Scoliosis
				396	19	7/12	
				3,112			

tion or tumor to nerves cannot be ruled out in this case.

4. Changes similar to those to be described in the present study were seen in a patient (12) irradiated at the age of two and one-half weeks for an hemangioma of the lower extremity. The dosage to the distal femoral epiphysis is estimated at 2,992 r. At the age of sixteen shortening of the extremity amounted to 9 3/4 inches. Transverse growth lines appeared at the metaphyses and two exostoses cartilagineae arose in the field of irradiation. One of these was removed and the other can be seen in the published roentgenogram.

MATERIALS AND METHODS

The records of all patients who received roentgen therapy prior to Jan. 1, 1950, at the Children's Hospital of Boston were reviewed. All patients in whom the field of roentgen therapy included a portion of the spine were selected for study, provided there were available adequate roentgenograms in two projections prior to roentgen therapy. The disease for which radiation was administered varied from benign hemangioma to intra-abdominal cancer, principally neuroblastoma or embryoma.

To limit the study to the effects of roentgen irradiation on the growth and development of the vertebral body, all patients were eliminated whose course was complicated by metastatic involvement of the spine by tumor, evidence of invasion of the neural canal by tumor, or therapy in which radioactive isotopes or folic acid antagonists were used. In the remaining patients it was reasonable to assume that any common alteration of growth and development observed in the irradiated vertebral bodies was attributable to roentgen therapy. Thirty-four of these patients were reexamined, including roentgen examination

TABLE II: EFFECTS OF IRRADIATION ON VERTEBRAE IN 11 PATIENTS WHO DIED

Case	Age at Initiation of Treatment (yr.)	Interval Between Irradiation and Death (yr.)	Tissue r to Spine	Treatment Course (days)	Interval Between Courses (yr.)	Pathologic Findings			
						Macerated Specimen	Growth Retardation	Cartilage Degeneration (microscopic)	Intensified Transverse Trabeculation (microscopic)
1	2 8/12	5/12	890	11		Neg.	+	+	–
2	2 8/12	5/12	1,210	13		Intensified transverse trabeculation	+	++	++
3	1	1/12	1,360	12		Intensified transverse trabeculation	+	+	++
4	1 3/12	8/12	1,910 610 540	17 8 6	 2/12 5/12	Intensified transverse trabeculation	++	+	+++
5	4 6/12	3/12	2,680	40		Intensified transverse trabeculation	++	+	+++
6	2 6/12	8/12	2,240	22		Intensified transverse trabeculation	++	+	++
7	5 8/12	3/12	2,100	20		Intensified transverse trabeculation	++	+	++
8	1 4/12	1 1/12	2,360	36		Intensified transverse trabeculation	++	++	++
9	11 6/12	2/12	240	7		Neg.	+++	+++	Neg.
10	5/12	3/12	300	7		Neg.	+++	Neg.	Neg.
11	4 4/12	3/12	360 (L2) 944 (D7)	9 9		Neg.	++	+	Neg.

Note: Tabulation of depth dose calculated to central vertebrae, age at treatment, and postmortem findings in patients on whom autopsy material was available. Pre- and postmortem roentgenograms of the spine revealed no specific changes in this group except for slight irregularity of the vertebral epiphysis in Patient 7.

of the spine (Table I). Postmortem material from 11 additional patients was available, including the vertebral bodies within and out of the field of roentgen therapy (Table II).

All of the patients listed in Table I were re-examined roentgenographically for the purposes of this special study and all but two were re-examined physically. The roentgen therapy record was studied and calculations were made of the depth dose, in roentgens, delivered to the spine during the irradiation.

In order to strike a common denominator for the variations in the methods of administration of radiation therapy, the depth dose delivered to the center of the vertebral body closest to the central beam was calculated. This is the dosage figure shown in Tables I and II for each course of radiation therapy. A radiation course consisted of daily (except Sunday) treatments, usually fractionated into equal air doses of 200 r. The kilovoltage was usually 200 kv. with a beam of half-value layer of either 1.05 or 1.55 mm. of copper. A few of the patients were treated at 160 kv., with a half-value layer of approximately 0.7 mm. of copper.

The patients included in Table II were subjected to postmortem examination, which consisted of routine gross and microscopic examination of viscera and, in addition, the removal *en bloc* of all of the

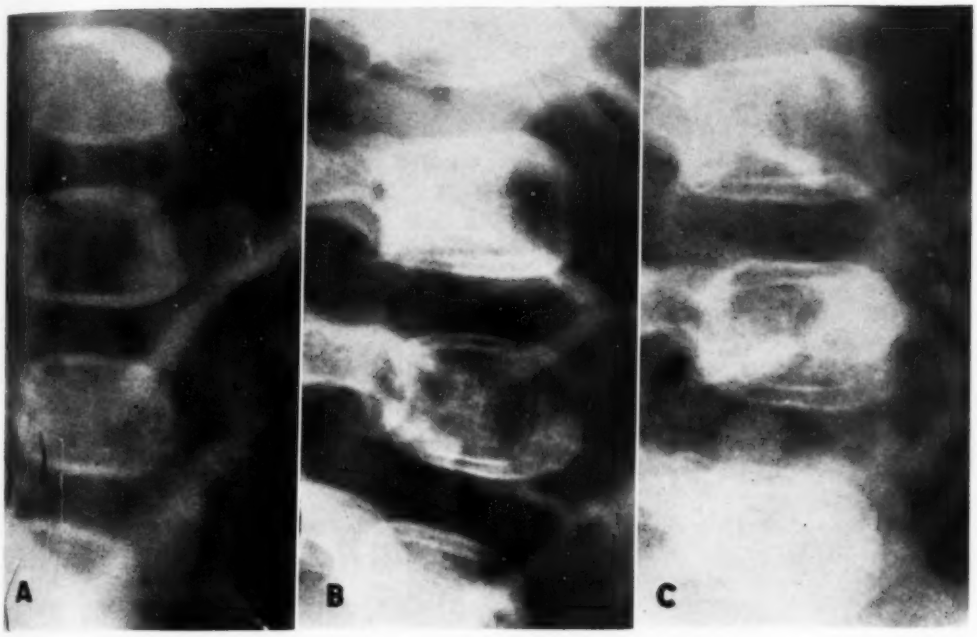

Fig. 1. Development of transverse lines Lateral views of the lumbar spine at one-year intervals after postoperative roentgen therapy for neuroblastoma in a seven-month-old infant. The calculated incidental dose to the body of L-2 was 1,360 r in eleven days and, two months later, 626 r in five days.

A. One year after treatment. A line of increased density is noted running parallel and very close to each epiphyseal plate. Similar lines, running transversely, were seen in the anteroposterior projections of the vertebrae.

B. Two years after treatment. The lines are separated from the adjacent epiphyses by normal trabecular bone presumably formed subsequent to the incident producing the growth disturbance. The total appearance is suggestive of *os in os* or a bone within a bone. The overall contour of the vertebral bodies is not abnormal.

C. Four years after irradiation. The vertebral bodies have apparently grown at the normal rate, but the lines of increased density retain their original relationship to each other. Thus there remains a permanent record of the outline of the bone when the temporary growth disturbance occurred.

bodies of the thoracic and lumbar vertebrae. The column of vertebral bodies was sawed in two anteroposteriorly and fixed in formalin. Sections were made from vertebral bodies in the field of irradiation and from those furthest from that area. Decalcification was by 5 per cent nitric acid followed by celloidin embedding and staining with hematoxylin and eosin. Another thin slice of the vertebrae was subjected to a process similar to potassium hydroxide maceration to demonstrate the gross trabecular structure of the bony lattice.

ROENTGENOLOGIC FINDINGS

Data concerning the age, dosage, and roentgenologic changes in the 34 living patients are charted in Table I. Thirteen of these patients showed no deviation from the normal. The remainder showed three principal types of change in the vertebral bodies.

1. Horizontal transverse lines of increased density, parallel to the epiphyseal plates, associated with very slight diminution in the height of the vertebral body (Fig. 1). A normal trabecular pattern was interposed between the transverse line and the current zone of provisional calcification. Occasionally the configuration appeared as a vertebra within a vertebra, an *os in os*. At times horizontal trabeculation was prominent beneath the zone of provisional calcification, but the transverse line was denser than the trabeculation and was situated in an area which corresponded to the zone of provisional calcification at the time of initial treatment.

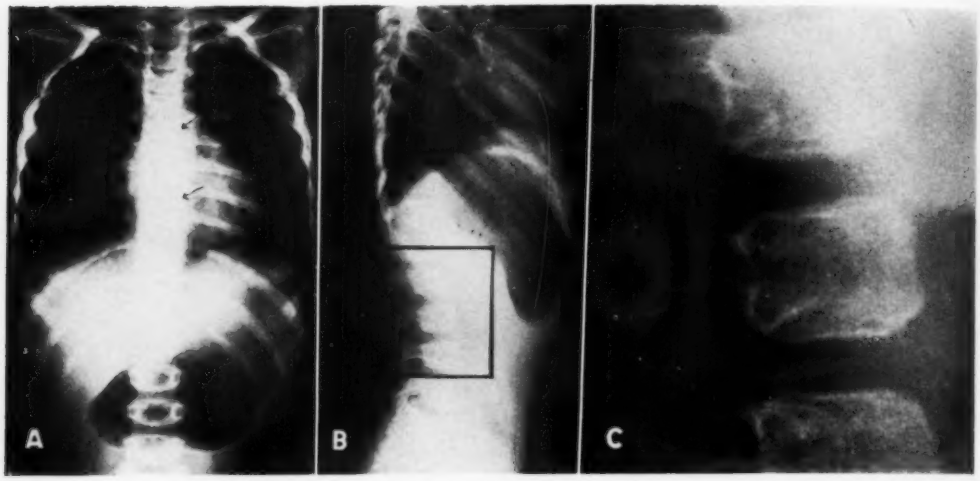

Fig. 2. Roentgenograms of the spine illustrating transverse lines in the vertebral bodies which are not growth disturbance lines and are readily distinguished from those of Fig. 1. This child suffered a severe systemic disease with marked demineralization of all the bones of the body, including the vertebrae. These transverse lines are convex centrally and represent an invagination of the vertebral plates into the softened porotic vertebral bodies similar to the deformities commonly seen in postmenopausal osteoporosis of the female. Although this child received irradiation, the changes are not limited to the field of therapy as in the case shown in Fig. 1. In A and B one can see actual anterior wedging of the bodies or anterior compression fractures resulting from the systemic demineralization outside of the field of therapy. C is an enlargement of the midlumbar region, the field of irradiation, illustrating the curved invagination of the vertebral plates and severe demineralization.

These transverse lines tend to be straight or convex and resemble the common "growth arrest" lines so often seen in long bones following systemic illness. They are to be differentiated from the concave lines of invagination of the vertebral plate by bulging disks (Fig. 2).

2. Gross irregularity or scalloping of the vertebral epiphyseal cartilage plates (Fig. 3). This change was associated with transverse lines of growth disturbance and also with stunting of axial growth of the vertebra. It occurred only within the field of radiation treatment. Transverse lines, while more intense in the irradiated vertebrae, also could be seen in non-irradiated vertebrae and therefore may reflect the systemic disturbance associated with the primary disease. The retardation of growth, while of minor degree, seemed greater in vertebrae exhibiting the "irregular" type of change than in those showing only transverse lines.

3. Gross contour abnormalities. This type of change, while it varied in degree, could be found only in the field of therapy. The 2 patients with the severest changes are shown in Figs. 4 and 5. This disturbance of normal contour was accompanied by the most marked retardation of axial growth seen in this study. The contour abnormality was best seen in the lateral roentgenogram and consisted of a biconvex, irregularly oval configuration which was similar to, and at times indistinguishable from, osteochondrodystrophy (Fig. 6). In several of the patients who exhibited the more severe contour abnormalities slight irregularity in the zygoapophyseal articulations also developed.

Two additional changes were noted in the roentgenograms of the patients of this series. The first of these was a scoliosis or lateral curvature of the spinal axis. The maximal curvature observed measured twelve degrees and in this patient a minor rotary component in the curve was present. The scoliosis was not detected clinically in any case and caused no functional physical handicap.

The second change worthy of mention occurred in bones other than the spine

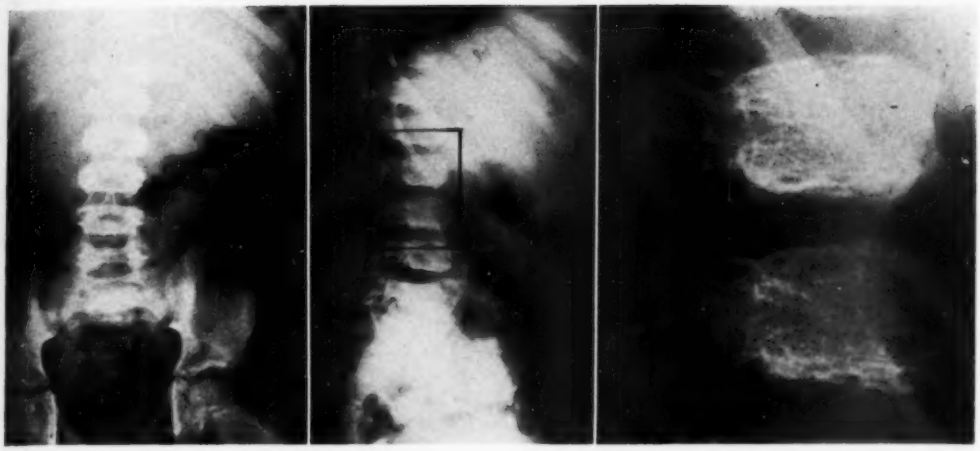

Fig. 3. Irregular conversion of cartilage to bone. Films of the lumbar spine ten years after postoperative roentgen therapy for embryonal carcinoma of the testicle in a sixteen-month-old child. The calculated incidental dose to the body of L-2 was 1,245 r in forty-two days and, one month later, 1,455 r in fourteen days.

Multiple transverse lines are visualized, but in addition there is evidence of irregular epiphyseal advance with lack of uniformity of conversion of cartilage to bone. These changes are indicated by scalloping and discontinuity of the epiphyseal plates and scattered subepiphyseal areas of radiolucency. It may be conjectured that the latter are analogous to the conversion abnormalities seen in long bones. The gross contour of the vertebral bodies is not significantly altered, although there is considerable irregularity of the margins.

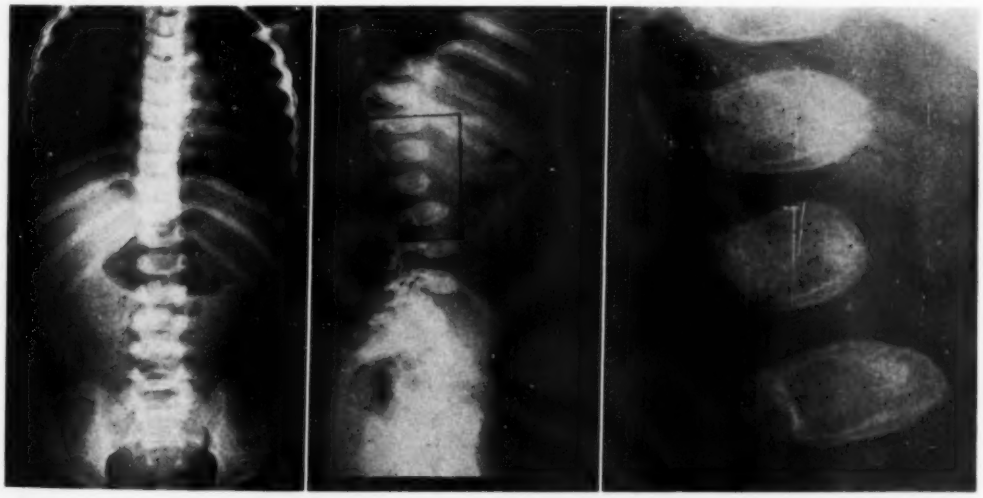

Fig. 4. Abnormal contour of the vertebral bodies. Films of the lumbar spine four years after the initiation of roentgen therapy for inoperable neuroblastoma in a four-month-old infant. The calculated incidental dose to the body of L-2 was 2,726 r in twenty-four days and, eight months later, 396 r in nineteen days.

Here there has been sufficient interference with epiphyseal advance to produce gross abnormality of vertebral contour. This is manifested by flattening of the bodies, with blunting and rounding off of the anterior margins of the superior and inferior surfaces. Note the faintly visualize dimage of the vertebrae within the vertebrae, corresponding to the contour of the bodies at the time of treatment. The present irregular contours of the bodies are seen to have been added since that time, thus documenting the abnormal growth since therapy. This type of growth disturbance illustrates the transverse growth lines and so-called *os in os* appearance.

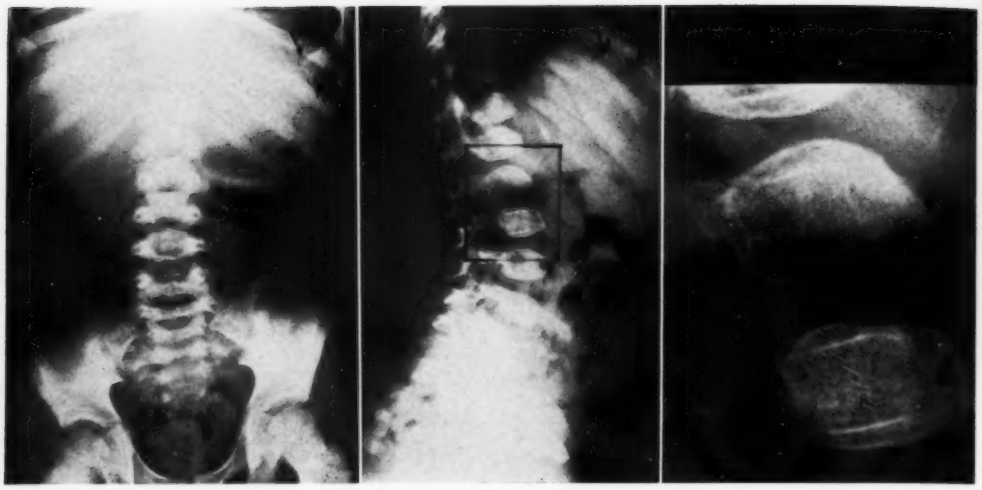

Fig. 5. Abnormal contour of the vertebral bodies. Films of the lumbar spine four years after the initiation of roentgen therapy for inoperable neuroblastoma in a four-month-old child. The calculated incidental dose to the body of L-2 was 730 r in eleven days, one month later 578 r in eight days, three months later 462 r in eight days, and two months later, 760 r in eight days.

The roentgen changes are essentially similar to those seen in Fig. 4, except that a mild lumbar scoliosis has developed. Of further interest is the presence of an exostosis cartilaginea arising near the anterior end of the left seventh rib, an area which was within the field of radiation.

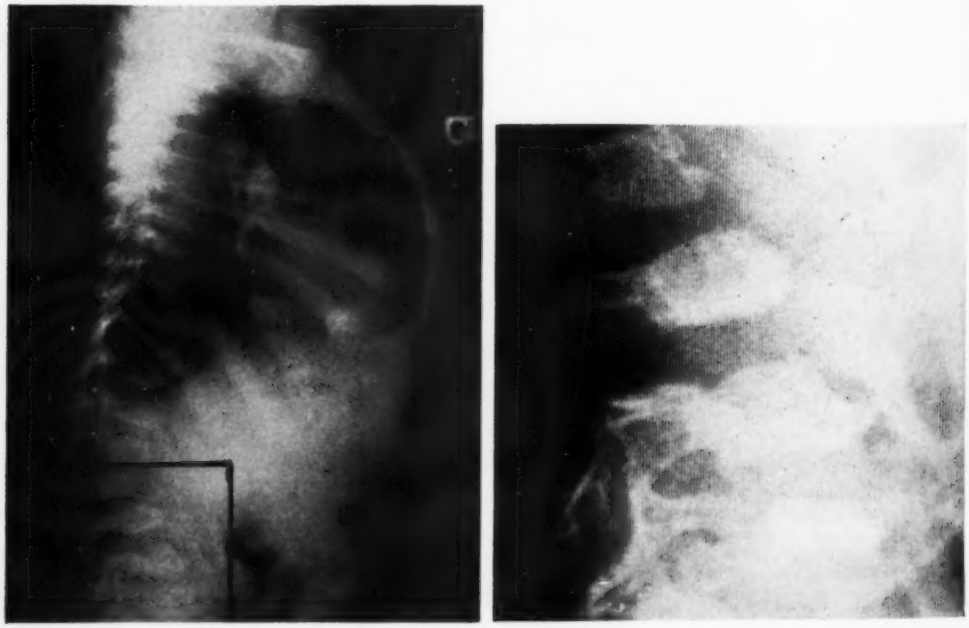

Fig. 6. Lateral view of the lumbar spine of a boy of three years and five months who was referred to the hospital for study because of deformity of the spine and chest. Films of all the bones showed the typical manifestations of osteochondrodystrophy of the Morquio type. Note the similarity of the radiographic appearance of the abnormally shaped vertebral bodies to those shown in Figs. 3 and 4.

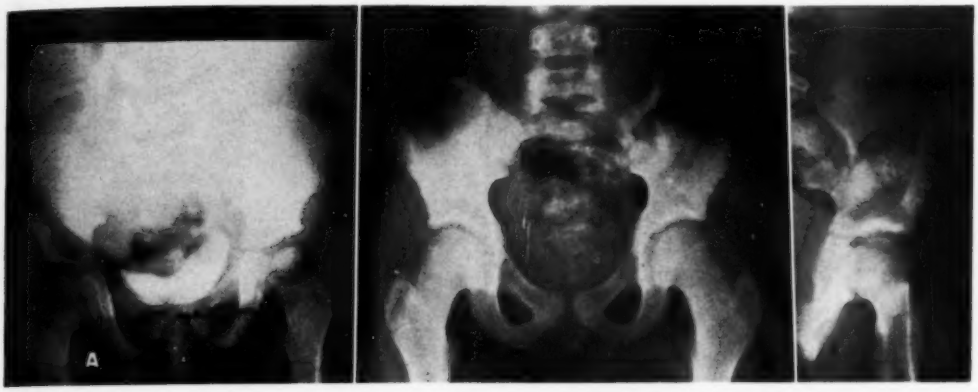

Fig. 7. Development of an exostosis cartilaginea in the field of irradiation on the left ilium. This child was treated for an embryoma of the left kidney and received a calculated total tissue dose of 800 to 1,000 r to the left ilium delivered in fractionated equal daily treatments over fifteen days. A. Pelvis shown to be normal just prior to irradiation. B and C. Pelvis six and a half years later. Note the broad-based exostosis arising from the iliac fossa on the left. The mature bony base, representing the site of origin, corresponds to the position of the epiphysis of the ilium at the time therapy was instituted. (Patient 21, Table I).

which were included within the field of irradiation. In 5 of the 34 patients, exostoses cartilagineae were noted on the ribs or in the ilium. They differed roentgenologically in no way from the usual type of exostosis of idiopathic origin (Figs. 5 and 7).

PATHOLOGICAL DATA

The patients studied by pathological technics are listed according to age, dosage, and findings in Table II. Grossly, there were no deviations from the normal appearance of the vertebral bodies of irradiated and non-irradiated areas. Microscopically, changes characteristic of growth retardation occurred, not only in the area of roentgen treatment, but in other areas as well. These changes consisted of a decrease in thickness and activity of the proliferative cartilage and the deposition of a thin bony plate on its under surface (Fig. 8). Small areas of degeneration of cartilage were found in the irradiated vertebrae in significantly greater numbers than in the non-irradiated vertebrae (Fig. 9). The impression was gained that the patients receiving higher doses of radiation had more areas of degeneration. No vascular changes due to irradiation could be demonstrated. In 6 patients there was a predominance of transverse trabeculation demonstrable grossly in macerated specimens, as well as in microscopic sections. These lines were present in the patients living longest after irradiation, but are not regarded as specific changes since they were found in non-irradiated regions as well as irradiated, and since they have been noted also in patients who have died of chronic systemic disease. It must be emphasized that the time interval between roentgen therapy and postmortem examination (Table II) was very short compared with the follow-up period of the living patients (Table I).

DISCUSSION

The growth disturbances described in this study (Table I) are presented graphically in Figure 10. Each patient is represented by a symbol characterizing the type of response to irradiation and is placed according to the age when roentgen therapy was begun (abscissa) and according to the total dose delivered to the spine (ordinate). While statistical analysis is not attempted with this small number, there is, however, an apparent grouping of patients with similar responses or growth disturbances that suggests that the effect upon growth is related to age and to dosage.

A. Effect of Radiation Dosage:

1. More than 2,000 r delivered to the

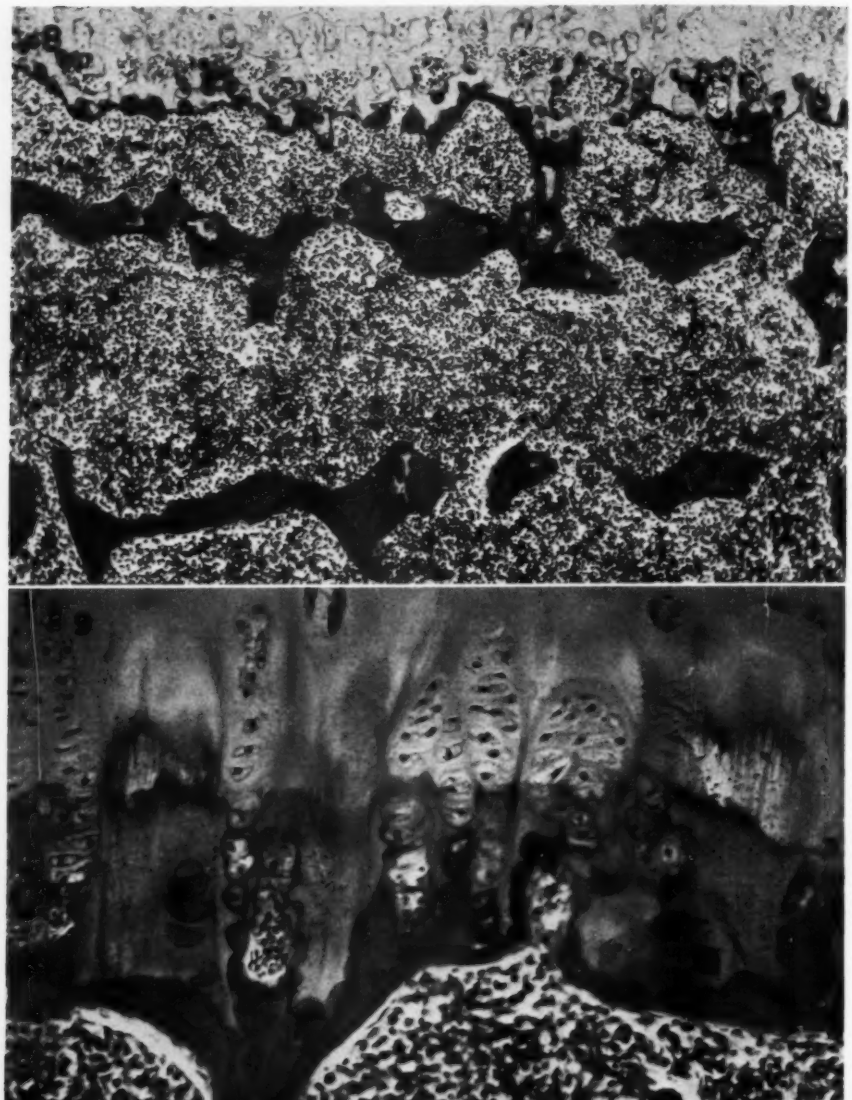

Fig. 8. Specimen illustrating most severe pertinent changes recognized by pathologic examination (Case 9, Table II). Intensification of the horizontal trabeculation is noted. The plate of bone underlying the calcified cartilage is seen. This bony plate, together with retarded endochondral sequences, is the pathological picture associated with growth retardation. The calcified cartilage and thickened bony plate can be seen as lines of increased density on the roentgenogram.

Fig. 9. Illustration of a few areas of degeneration of cartilage matrix in the area in the zone of endochondral bone formation. Growth retardation changes are manifested by inactive endochondral ossification sequences and subchondral bony plate formation.

spine caused the most severe type of vertebral disturbance: contour irregularity. It was observed in all children receiving this amount of radiation or more, with one exception. This was a child (Case 13, Table I) nine years old at the time of

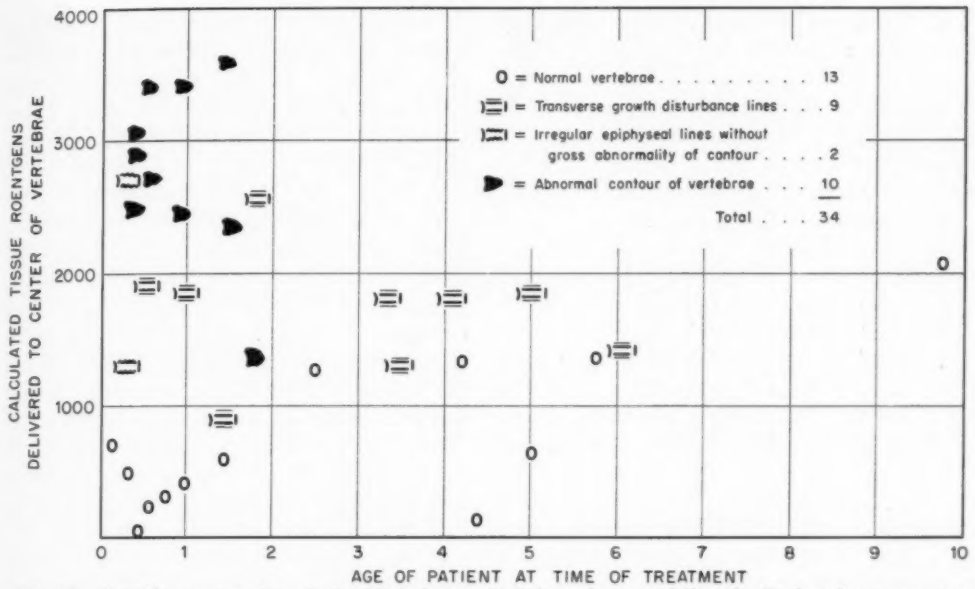

Fig. 10. Graphic presentation of the 34 patients still living who were followed. Each point represents a patient placed according to age at time of treatment (abscissa) and the tissue roentgens delivered to center of the vertebra (ordinate). The roentgenographic findings on follow-up examination, two years and seven months to thirteen years following irradiation, are shown by schematic drawings. Note that the 12 patients showing no detectable abnormality on follow-up lie predominantly in the lower dosage range, permitting some increase with advancing age. The 10 patients showing the severest change lie in the high dosage area and in the lower age level at the time of treatment.

treatment who showed no evidence of growth disturbance three years and eight months later.

2. Less than 1,000 r caused no detectable vertebral abnormality, irrespective of the patient's age at the time of treatment. Most of the 13 patients in this study who showed no vertebral changes fell into this dosage category, including 6 infants below the age of one year.

3. Doses between 1,000 and 2,000 r usually caused the "transverse line" growth disturbance whatever the age at treatment. Three patients in this dosage range, however, showed no detectable changes whatever, and 1 patient showed the scalloping change indicative of a growth disturbance intermediate in severity between the transverse line and the contour abnormality.

B. Effect of Age at Time of Irradiation: The more severe changes occurred in patients aged two years or younger at the time of irradiation. The effects were more pronounced when the dosage exceeded 2,000 r. Only one infant tolerated this dose without the production of abnormality in contour of the vertebrae, and he showed the intermediate scalloping change.

Less severe changes were produced at ages below the six-year level, namely the transverse growth disturbance line, with doses of 1,000 to 2,000 r.

Both roentgenologic and pathologic evidence indicate that the changes described required many months or years to become manifest. Therefore, in the two infants who received 1,986 and 1,880 roentgens respectively, and were followed for only a three-year period, contour abnormalities may still develop.

With a single exception the children included in this study did not exceed six years of age. Moreover, and also with one exception, all patients receiving the higher dosage were under two years of age. The limitations of our data with respect to older children receiving the higher dosages must be kept in mind.

C. "Stunting of Height" as a Result of Irradiation: The often feared complication of radiation therapy over the spine is quantitatively not alarming as long as only a few vertebrae are irradiated. One gained the impression in these follow-up examinations that the affected vertebrae were slightly flatter than normal. Comparative study, however, reveals that the heights of these irradiated vertebrae fall within the lower range of normal variation. If three or four vertebral bodies included in a field of therapy show a 10 per cent diminution in height, it is evident that the effect on the total height of the vertebral column, arising from forty-six pre-sacral epiphyseal plates, would be affected only slightly. It has been reported in experimental work (6) that, if one epiphysis of a long bone is retarded in axial growth as a result of radiation, the remaining epiphysis will show an acceleration in growth, in part compensating for the radiation effects. The quantitative changes in the spine were so slight that the presence or absence of this phenomenon could not be detected.

D. Scoliosis as a Result of Irradiation: Three of the 34 patients showed evidence of scoliosis on roentgenographic examination (Table I, Cases 32–34). These changes in the weight-bearing column of the spine were of such small magnitude as to be clinically indetectable. Roentgenographically, the maximal lateral curvature was 12 degrees (Case 33), with a mild rotary component.

None of the patients in this group was physically handicapped in normal everyday activity by the observed deformities of the spine. In our experience with tumor patients receiving x-ray therapy, scoliosis later in life is not uncommon. However, the vast majority of these cases are of neurogenic origin, in which the tumor itself either involved the nerve roots or the neural axis by direct invasion of the spinal canal. As has been previously noted, in order to limit this study to the effects of irradiation alone, all patients showing evidence at any time of involvement of the spinal canal by tumor were excluded from the tabulation, thus leaving only 3 patients with a mild scoliosis attributable to radiation therapy, despite the much higher incidence of abnormal advance of the epiphyses. One such case is illustrated in Figure 5.

It must be remembered that a true scoliosis of primary osseous origin can be produced by radiation. This has been done experimentally in animals by Arkin (15, 19) and Engel (20), using both external roentgen radiation and radium implants in paraspinal tissue. Although the effects on the epiphyses of the vertebral bodies are undoubtedly the same as in the children treated in our series, they were directed in such a manner as to produce an uneven absorption of radiation by the epiphyseal plates. In fact, the most dramatic examples of scoliosis in the animal experimental work were produced by shielding half of the vertebrae, by placing a linear source of radiation in close proximity to the lateral aspect of one vertebral plate, or by directing external radiation toward the spine obliquely through a lateral port. In these instances, of course, one-half of each vertebral plate received all or the major portion of the irradiation and consequently showed the maximum growth retardation effect, resulting in wedge-shaped vertebrae and scoliosis.

E. Technic of Radiation Therapy and Deformities of the Spine: The above findings are noteworthy in that they reemphasize the point that if the spine is to be included in the field of irradiation in a growing child, as it must in the paraspinal neuroblastomas, the fields should be so arranged that the spine receives uniform intensity of irradiation throughout the course of therapy. It is for this reason that we prefer true anteroposterior portals. Lateral and tangential ports may give sufficient variation in intensity of radiation to the epiphyseal plates of the spine to produce scoliosis by the irregular advance of the epiphyses.

Caution should also be exercised in the treatment of unilateral intra-abdominal tumors of childhood. If therapy is limited to

one-half of the abdomen, it would seem advisable to bring the ports slightly beyond the midline, so that the entire transverse diameter of the spine is included, receiving irradiation of fairly uniform intensity. If the entire abdomen requires treatment and it must be subdivided into quadrants, caution should be exercised in avoiding quadruple cross-firing of the spine, producing a so-called "hot spot" in the region of the first or second lumbar vertebra.

F. Exostoses Cartilagineae in Patients Irradiated: Another observation of clinical interest was made on this series of children. Five of the living patients developed exostoses cartilagineae on bones within the fields of irradiation other than the spine. Each of these presented the typical appearance of a benign cartilaginous growth arising from the epiphysis, similar to those so commonly seen in the multiple familial form. It is believed that this incidence is significantly higher than in the normal population and that irradiation may well be a contributing factor. Two such patients are illustrated in Figures 5 and 7.

SUMMARY

1. Thirty-four children who had received irradiation in which the spine was included in the field of therapy were restudied at intervals ranging from two years and two months to thirteen years and three months following treatment. Although a statistical analysis of these patients is impossible, it appears that growth disturbances produced by radiation in the human vertebrae are directly related to dosage and inversely related to age.

2. Experience with this group of children would indicate, as a preliminary guide for therapy, that dosages under 1,000 tissue r usually fail to produce a gross permanent deformity of the vertebrae in a growing child, probably irrespective of the age at which treatment is given. Children over two years of age may tolerate between 1,000 and 2,000 r delivered to the spine with only minor growth disturbance, but dosages in excess of 2,000 tissue r, irrespective of the age of the child, will probably produce growth disturbances. In our series the majority of these disturbances were associated with gross abnormality of contour of the vertebrae. Scoliosis is only rarely produced if the spine receives uniform radiation.

3. The significant changes on 11 postmortem examinations were non-specific growth retardation and irregularity of ossification of the epiphyseal cartilage. These changes may lead to an irregular advance of the line of ossification, but no gross alterations of osseous contour were observed, presumably because the interval between irradiation and death was too short in this group of patients.

4. Benign exostoses cartilagineae of the type so commonly seen in multiple and familial form appear to arise with greater frequency in bones whose epiphyses have been irradiated than in the normal population.

5. It is believed that when irradiation is definitely indicated in paravertebral tumors of the spine, x-ray therapy can be so directed as to produce minimal disturbance in development of the spine.

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SUMARIO

Los Efectos de la Roentgenoterapie sobre el Raquis en Vías de Desarrollo

Treinta y cuatro niños que habían recibido irradiación, comprendiendo el raquis en el campo terapéutico, fueron estudiados de nuevo de los 2 2/12 a los 13 3/12 años del tratamiento. Aunque es imposible hacer un análisis estadístico de esos enfermos, parece que los trastornos del crecimiento producidos por la irradiación en las vértebras humanas guardan relación directa con la dosis e inversa con la edad.

Lo observado en este grupo de niños indica, como guía preliminar de la terapéutica, que dosis de menos de 1,000 roentgens en los tejidos no suelen producir permanente deformidad macroscópica de las vértebras en un niño en desarrollo, probablemente sin referencia a la edad a la que se administra el tratamiento. Los niños de más de dos años pueden tolerar entre 1,000 y 2,000 roentgens entregados a la espina dorsal sin más que pequeños trastornos del desarrollo, pero dosis superiores a 2,000 roentgens en los tejidos producirán con toda probabilidad, independientemente de la edad del niño, tales trastornos. En esta serie, la mayoría de los mismos se asoció con anomalía macroscópica del contorno de las vértebras. La producción de escoliosis es rara, si el raquis recibe radiación uniforme.

Las alteraciones significativas observadas en 11 autopsias consistieron en retardo anespecífico del desarrollo y osificación irregular del cartílago epifisario. Esas alteraciones pueden conducir a avance irregular de la línea de osificación, pero no se observaron cambios macroscópicos del contorno óseo, presuntamente por ser demasiado corto el tiempo transcurrido entre la irradiación y la muerte.

Las exostosis cartilaginosas benignas, tan a menudo observadas en forma múltiple y familiar, parecen presentarse con mayor frecuencia en huesos cuyas epífisis han sido irradiadas, que en la población normal.

Parece que, cuando la irradiación está netamente indicada en los tumores paravertebrales, la roentgenoterapia puede ser dirigida de manera que produzca mínimos trastornos en el desarrollo de la espina dorsal.

On Some Late Skeletal Changes in Chronic Infantile Cortical Hyperostosis[1]

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INFANTILE cortical hyperostosis is usually a benign disease in which the clinical manifestations subside after a few weeks and the skeletal changes, demonstrated roentgenographically, disappear within a few months (Caffey). More than 50 such cases have been reported during the last six years and scores of others have been recognized in all parts of the United States and in many parts of the world. The benign features of the disorder and the good prognosis have become well known. The chronic type of infantile cortical hyperostosis with late crippling residuals in the skeleton has been observed in only a few cases and is generally little appreciated.

This report is a description of clinical and roentgen findings in a patient who has suffered from infantile cortical hyperostosis for more than two years and who is still deformed and disabled by late residuals in the skeleton. In the evolution of the late bone lesions, the early changes —external thickening of the cortical walls with a normal-sized medullary cavity— were later converted into thinned walls with dilated medullary cavity. Bone bridges between each ulna and radius and between contiguous ribs, found in this patient, are the first lesions of this type to be reported in infantile cortical hyperostosis. Persistent ventral bowing of the tibias (Smitham and Palmer; Kitchin), which did not occur in this patient, is discussed because it promises to be an important and not infrequent sequel of the disease.

CASE REPORT

B. L., a Negro girl, was born of a healthy, primiparous mother. She weighed seven pounds, and during the first three months thrived on a cow's milk formula, with daily supplements of one-half ounce of orange juice and eight drops of a concentrate of vitamins A and D.

When the baby was three months of age, the father had chickenpox, to which the infant was intimately exposed. Seven days later, large water blisters were said to have appeared on both her wrists and then spread, during three or four days, over the arms, neck, face, legs, and feet. The physician who examined her at home stated that the rash was not characteristic of chickenpox. With its onset the child became feverish and hyperirritable and ate and slept poorly. Five days after the cutaneous lesions appeared, the left forearm became swollen and tender, and then the jaws, entire right arm, and the entire right leg. These swellings enlarged slowly during a period of seven days. After admission to the Willard Parker Hospital, a city hospital for contagious diseases, roentgenograms disclosed thickenings of the bones which led to the diagnosis of infantile cortical hyperostosis. No signs of chickenpox were observed at that institution.

When four months of age, the child was admitted to the New York Hospital with a fever of 37.5° C. She was exceedingly miserable and hyperirritable, with massive swellings in the face, trunk, and extremities (Fig. 1). Skin over the swellings was tight and shiny; in some places there was fine and, in others, coarse desquamation. The swollen right arm was held motionless in partial abduction, and movements everywhere were greatly limited. Lymph nodes regional to the swellings were not enlarged. Mucous membranes of the eyes, nose, and mouth were normal.

The right clavicle was thickened to palpation. The intrathoracic, abdominal, and pelvic structures were normal. The right side of the vulva was not swollen, notwithstanding the neighboring massive swelling of the right thigh. All of the swellings were hard; they did not pit on pressure and were not discolored or overly warm. There was a conspicuous lack of swelling of the left upper arm and the entire left leg. Neurologic examination was unsatisfactory owing to the tense swellings, hyperirritability and painful pseudo-paralysis.

The urine was normal chemically and cytologically. Blood studies showed hemoglobin 8 gm. per 100 c.c.; red blood cells 5,000,000 per c.mm.; white blood cells 25,000 per c.mm.; mature poly-

[1] From the Departments of Pediatrics and Radiology, New York Hospital. Accepted for publication in February 1952.

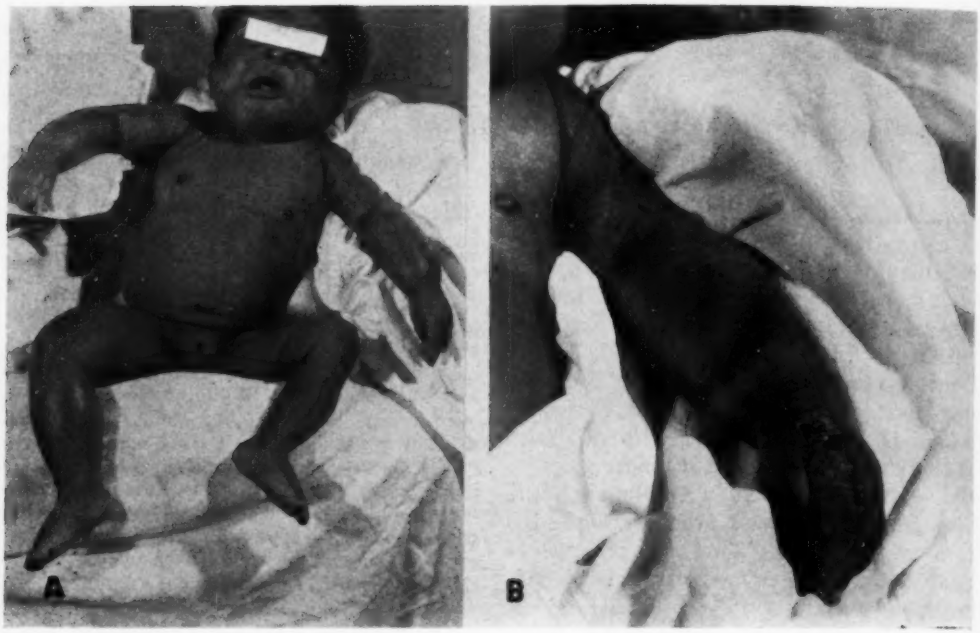


Fig. 1. A. Soft-tissue swellings of the face and extremities at four and a half months, four weeks after onset. The upper part of the left arm and the entire left leg are unaffected. B. Coarse desquamation of the skin of the left forearm and fine desquamation of the left upper arm at four and a half months of age.

Fig. 2. Mandibular hyperostosis six weeks after onset in lateral oblique projection. Body and rami are thickened and sclerotic. The condylar processes are little affected.

morphonuclears 78 per cent; band forms 14 per cent; lymphocytes 8 per cent; 2 nucleated red blood cells per 100 white blood cells. The erythrocyte sedimentation rate was 33 mm. in one hour. In a specimen of bone marrow taken from the iliac crest the cellular elements were normal save for the high content of myeloid cells, which are usually indicative of active infection.

Serum phosphatase activity varied between 71 and 14 Bodansky units. Concentrations of urea nitrogen, cholesterol, calcium, phosphorus, ascorbic acid, and vitamin A in the blood were all normal. Blood cultures yielded no growth and there were no predominant pathogens in cultures from nose and throat. A Mazzini test on the blood serum gave a non-syphilitic reaction.

Roentgen examinations disclosed massive external thickenings of the bones which underlay the soft-tissue swellings (Figs. 2–5). Strips of increased density between the inner surfaces of the ribs and the edges of the lungs suggested that there were substantial amounts of either intrapleural or extrapleural fluid in these regions. There was a conspicuous absence of cortical thickening in the left upper arm and the entire left leg, where there were no soft-tissue swellings.

Specimens taken at biopsy from the right inguinal lymph nodes showed normal microscopic structures. Specimens from the thickened cortical wall of the right tibia disclosed closely crowded,

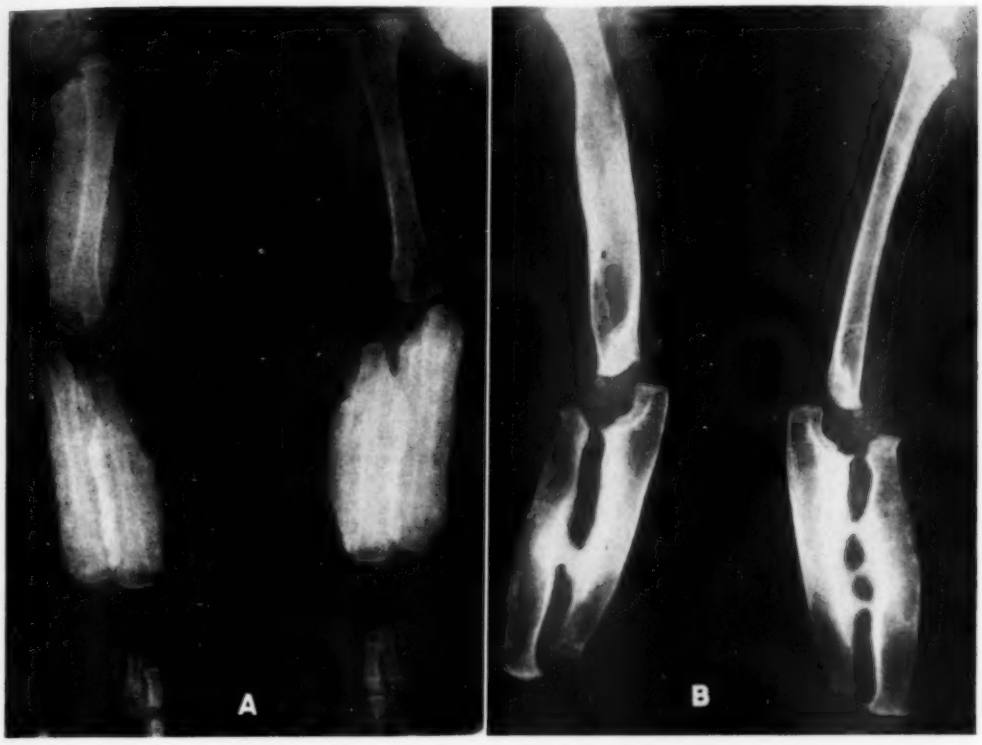
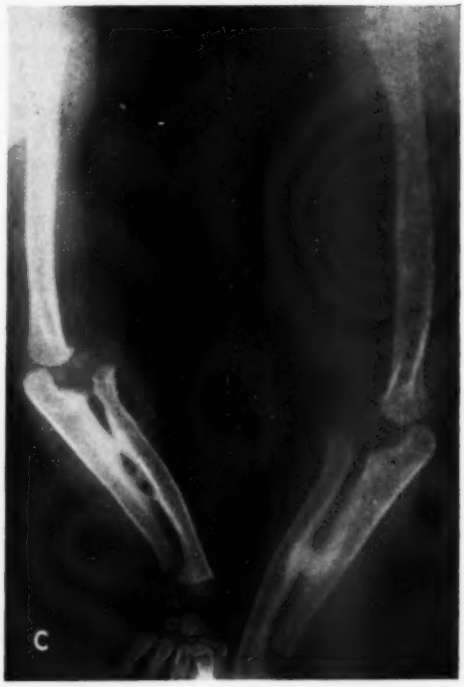


Fig. 3. Serial changes in the arms.

A. At four and a half months, four weeks after onset. Massive rough, external cortical thickenings envelop the shafts of all the long tubular bones except the left humerus, over which there was no swelling of soft tissues. Original cortical walls are still visible, buried deep inside thick sheaths of newly formed cortical bone. The swollen radius and ulna in each forearm overlap and impinge on each other at their contiguous surfaces. The metaphyses of the affected bones are normal. The radial heads are dislocated.

B. At twelve and a half months, nine months after onset. All of the affected bones are still enlarged; the enlargement now, however, is due to expansion of the medullary cavities inside the cortical walls which have been reamed out from the inside, and are much thinner than before. There is a large single bony bridge between the right radius and ulna, and three smaller bridges between the left radius and ulna. The radial heads are still dislocated ventrad from the elbows.

C. At twenty-two and a half months, nineteen months after onset. All of the earlier changes are still present but are diminished. The total bulk of each bone is reduced owing to shrinkage of the medullary cavity while the cortical walls are thickening externally. Ventral dislocation of the radial heads is more marked than before.



fine spicules of newly formed bone arranged parallel to one another but perpendicular to the periosteum. The spaces between the spicules were filled with loose pale fibrous tissue. There was no microscopic evidence of old or recent subperiosteal hemorrhage or inflammation.

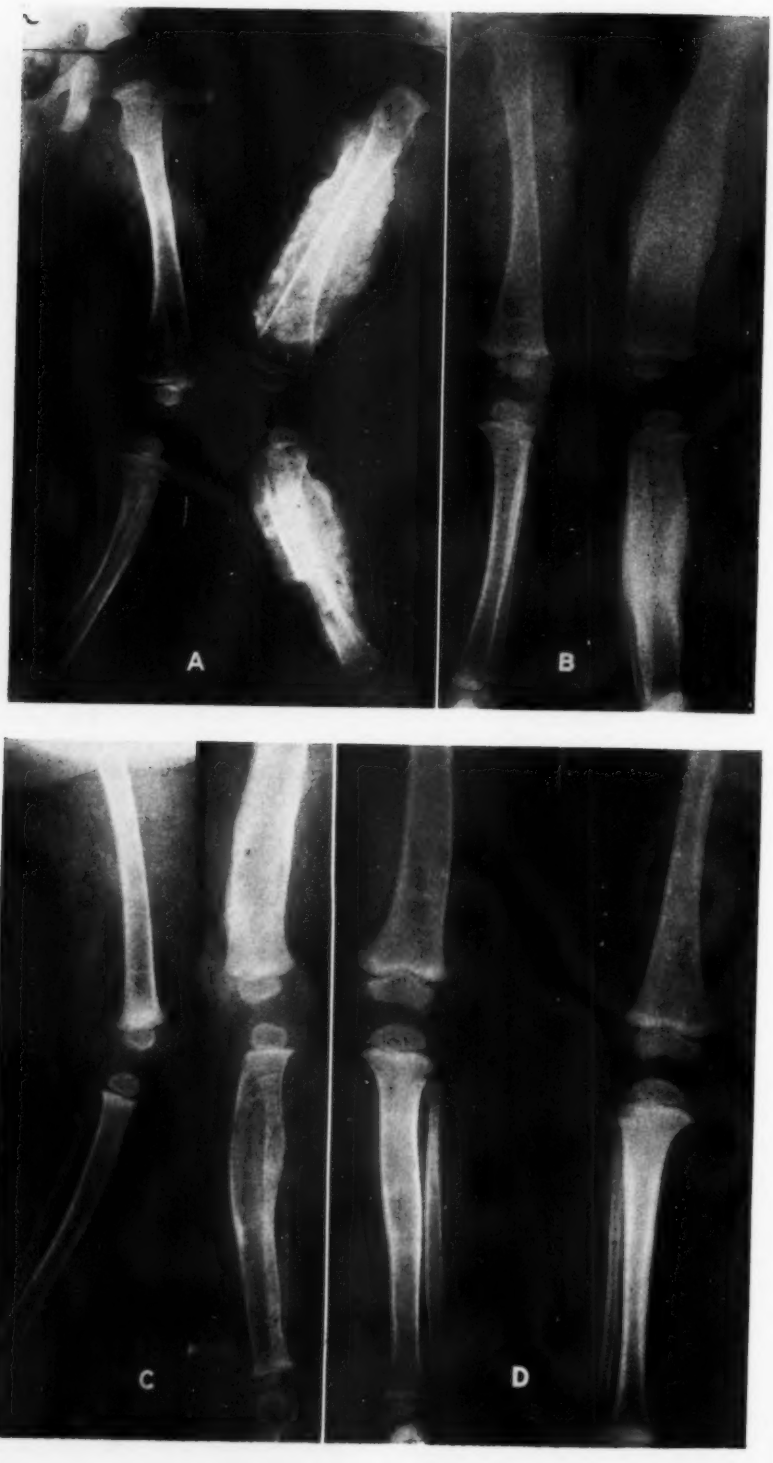


Figure 4 (For legend see opposite page)

Course: During the first thirty days of hospital residence, fever continued, with a temperature range of 37 to 38.5° C. The swellings persisted, with hyperirritability. Several transfusions were given to combat anemia, and sedatives were administered for the relief of pain. During the fourth and fifth weeks, the swellings began to subside slowly. Aureomycin was administered without notable effect. After forty-nine days the patient was discharged; she had no fever, but the hard swellings and limitation of movement were still present.

For several weeks following discharge, the child remained fever-free and, although the swellings were still very large, they seemed to be slowly diminishing in both size and tenderness. During the seventh month, however, fever recurred and at the same time the swelling in the right arm enlarged and became more tender. At the ninth month the swellings were smaller, harder, and non-tender. At one year, the patient was gaining weight satisfactorily and attempting to stand; she had been sitting up alone since the ninth month. Movements in the extremities were still limited, although all four extremities were moved voluntarily. The most marked limitations were in the forearms.

At the fourteenth month, when the child was being fitted for shoes, it was found that her right foot was larger than the left. Her right leg was 2 cm. longer than the left. She was now standing alone and could pull herself from a sitting into a standing position. The heads of the radii were palpable outside the elbows, where they produced visible swellings.

Mental development and nutrition were both normal at the twenty-second month. The jaws were still symmetrical. Motor power was generally good and the child walked well. The elbows were still swollen on their radial aspects and pronation of the forearms was sharply limited to 20 degrees in the right forearm and 15 degrees in the left forearm. The right leg was still larger and slightly longer than the left leg.

COMMENT

Progressive thinning of the thickened cortical walls, from the inside, and recip-

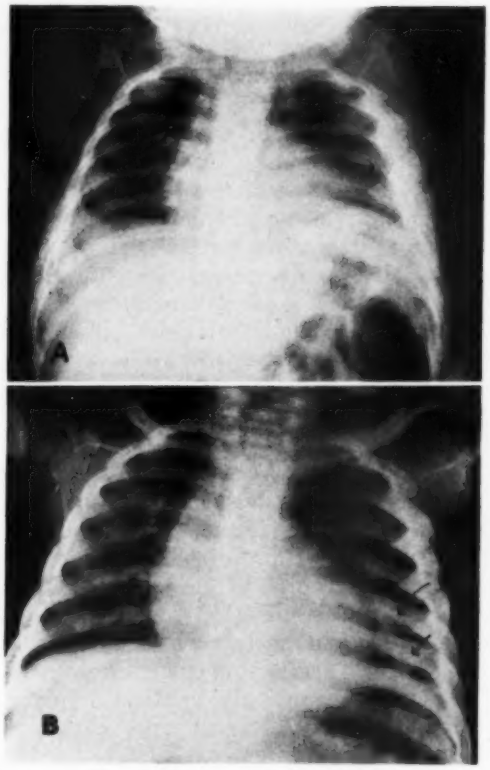


Fig. 5. Serial changes in the thorax.

A. At four months, two weeks after onset. Ribs on both sides are thickened and sclerotic and there are wide strips (arrow) of increased water density between the internal surfaces of the thickened ribs and the edges of the lungs. These strips represent accumulations of either intrapleural or extrapleural liquid. The left clavicle and left scapula are swollen and sclerotic; neither is well seen in this film.

B. At nine months, five and a half months after onset. Many of the ribs are still thickened and sclerotic; the earlier shadows cast by subcostal liquid have disappeared. The left clavicle and left scapula both show residual swelling. There are two bony bridges (arrows), one between the 6th and 7th left ribs, and a second between the 7th and 8th left ribs. In films made later, at one year of age, the bony bridges were still present and unchanged.

Fig. 4. Serial changes in the legs.

A. At four and a half months, four weeks after onset. Thick rough sleeves of excessive cortical bone surround the shafts in the right leg; the bones in the left leg are not affected.

B. At nine and a half months, six months after onset. The swollen bones now show the combination of thickened cortical walls with dilatation of the medullary cavities. The reaming out of the shafts is in the intermediary stage, in which the partially destroyed hyperostoses are still thick and the medullary cavities are overexpanded.

C. Lateral projections at twelve and a half months, nine months after onset. The internal atrophy of the cortical hyperostoses has continued and the walls of the right tibia and fibula are now paper-thin and envelop a greatly dilated marrow cavity. The tibial epiphyseal ossification centers are larger in the right tibia, which is slightly longer than the left tibia. The progressive changes have developed more rapidly in the right tibia than in the right femur, whose cortical walls are still thickened.

D. At twenty-two months, eighteen months after onset. The affected shafts are still too large, but are all diminished in bulk in comparison with C. While the medullary cavities have been shrinking, their cortical walls have been thickening on their external aspects.

rocal simultaneous dilatation of the medullary cavity, with the persistence of the early external swelling of the shaft, are the most important and characteristic features of the late changes in infantile cortical hyperostosis. Owing to the failure of remodeling of the shaft, the bulk remains increased and the normal external contours are obliterated. The swollen shafts also become slightly elongated and their secondary ossification centers in the epiphyses become over-large. The nature of the soft tissues which fill the expanded marrow cavity is not known. Pathological fractures of the thin-walled dilated shafts did not occur in the case reported here, but it seems reasonable to anticipate pathological fractures in other patients when extreme cortical atrophy develops.

The combination of internal cortical atrophy, expansion of the marrow cavity, and external swelling of the shaft, in the magnitude and pattern found in this patient, are in the light of current knowledge diagnostic of infantile cortical hyperostosis. Cortical atrophy and expansion of the marrow cavity are found in many severe cases of Cooley's anemia and in some cases of Hunter-Hurler disease (dysostosis multiplex, gargoylism), but other findings, both clinical and laboratory, easily differentiate these two disorders from infantile cortical hyperostosis. The evolution of the bone changes with late cortical atrophy are beautifully demonstrated by Sherman and Hellyer in their third case; the radius of this patient shows a thinned cortex and dilated medullary cavity thirteen months after onset. In this same swollen bone, cortical thickening recurred two months later, fifteen months after onset.

In the present case, bony bridges bound the radius to the ulna in each forearm, and the 6th to 7th and the 7th to 8th left ribs. These bridges appeared to be composed of sclerotic compact bone in which there were no marrow cavities. The bridges were probably residual to early local pressure necrosis of the periosteum, at sites where parallel massive cortical hyperostoses impinged on each other and then fused where the periosteum had disappeared. Dislocation of the radial heads developed early during a time when the impinging thickenings of the radius and ulna pushed the radial head ventrad and laterad out of the elbow; the dislocations were then maintained by the rigid bridges, which prevented return of the radial heads toward the elbows. This anchoring effect of the bridges was largely responsible for the limitations in movements in the forearms, which were the principal disabilities when the patient was last examined at twenty-seven months of age. It would seem that surgical excision or at least fracture of bridges of this kind could reduce the dislocations at the elbow and greatly improve pronation and supination. The intercostal bridges caused no disability in this patient. If, however, intercostal bony bridges should form at several levels in both sides of the thorax, they could conceivably reduce the amplitude of respiratory movements and vital capacity.

Ventral bowing of the tibias did not develop in this patient but has been an early and late feature in several reported cases (Smitham and Palmer; Kitchin). The early hyperostosis sometimes is disproportionately thick on the ventral wall; the external deformity of bowing has been seen during the first days of life. This early ventral bowing persists because, when healing begins, the thick hyperostosis is reamed out from the inside and there is failure of reshaping of the external contours of the shaft, which results in a swollen bone with an enlarged medullary cavity, all convex ventrad. In Kitchin's patient, bilateral ventral tibial bowings were demonstrated during the first hours of life; the bowings persisted and were pronounced in the thin-walled tibial shafts at one year. This latter case is an especially important one because the massive thickenings of the tibias demonstrated at so early an age had obviously been present for a long time prior to birth. Only the tibias were affected in Kitchin's patient; the diagnosis would have been more certain had the

mandible also been involved. In an unreported case of Dr. Henry Poncher and Dr. William Barba of Chicago, similar tibial lesions were present at birth, with thickenings of the mandible and several other bones. The tibial thickenings were demonstrated before birth in films made of the mother's pelvis. There are now three examples of infantile cortical hyperostosis in which it is certain that the onset of the condition preceded birth by several weeks.

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SUMARIO

Algunas Alteraciones Tardías del Esqueleto en la Hiperostosis Cortical Infantil Crónica

La hiperostosis cortical infantil suele ser una afección benigna en la que desaparecen las manifestaciones clínicas a las pocas semanas y las alteraciones esqueléticas, observadas roentgenográficamente, se disipan a los pocos meses.

La forma crónica de la hiperostosis cortical infantil con residuos incapacitantes tardíos no ha sido observada más que en pocos casos y es generalmente apenas apreciada.

Los hallazgos clínicos y roentgenológicos aquí descritos fueron en una niña negra con hiperostosis cortical, observada por primera vez a la edad de cuatro meses, y que al cabo de dos años estaba todavía deformada e incapacitada por secuelas tardías en el esqueleto. Las primeras alteraciones óseas—espesamiento externo de las paredes corticales con cavidad medular de tamaño normal—se convirtieron más tarde en adelgazamiento parietal con dilatación de la cavidad medular. Los puentes óseos entre cada cúbito y radio y entre costillas contiguas, descubiertos en esta enfermita, son las primeras lesiones de este género que se hayan descrito en la hiperostosis cortical infantil.

La combadura ventral de las tibias no se presentó en este caso, pero ha constituído una característica precoz y tardía en varios casos comunicados.

Anomalous Pulmonary Artery from the Aorta Associated with Intrapulmonary Cysts (Intralobar Sequestration of Lung)

Its Roentgenologic Recognition and Clinical Significance

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THIS DISCUSSION is concerned with the roentgen diagnosis of an anomalous systemic artery to the lung associated with congenital cystic pulmonary abnormalities. Seven cases proved by surgical resection and subsequent pathologic examination form the basis of the study. Although there are numerous reports in the literature by surgeons who have encountered anomalous arteries arising from either the thoracic or abdominal portions of the aorta and entering the lower lobes (1, 3, 4, 5, 7, 8, 11, 13, 16, 17, 18), very little reference has been made to the preoperative diagnosis, and particularly to the roentgen findings in these cases. Because a number of deaths have resulted from inadvertent section of such an artery during lobectomy or pneumonectomy (14), the vital importance of recognition of the condition prior to surgery is emphasized.

The artery is "pulmonary" in type histologically, being elastic rather than muscular (19, 20) and is frequently atherosclerotic (2, 8, 19). It may supply only normally connected lung, only sequestered lung, or both; it usually anastomoses with normal pulmonary arteries (6). In intralobar sequestration, venous drainage is to the normal pulmonary venous system; in extralobar sequestration, drainage is to systemic veins.

The pulmonary abnormality, sequestration of lung, consists in the presence of lung tissue which does not connect with the bronchial tree in the usual fashion. Lung so sequestered may lie within the lower lobe (intralobar) (19) or adjacent to the lower lobe (extralobar) (10, 12, 19), forming an accessory lobe or lung. The cases presented here are all of the intralobar type. The extralobar type will not be discussed.

The sequestered portion of the lung may be composed chiefly of normally differentiated lung, a system of branching bronchi, one or more bronchogenic cysts, or a polycystic mass. The fact that such cysts sometimes contain air suggests the probability of communication with the bronchial tree, although no communication was demonstrated in the cases presented.

The embryologic events responsible for the anomalous distribution of the arteries and the accompanying deformity of the lung, as well as the frequent association of hiatus hernia, have been the subject of discussion by many authors, notably Cockayne and Gladstone (9) and Pryce (19). It has been the opinion of most writers that the condition is of congenital origin. Although it cannot be disproved in any case that the cyst or cysts have been acquired, this possibility is believed to be remote (15).

In all of the cases presented, the pulmonary abnormality consisted essentially of bronchogenic cyst formation within a lower lobe. In none was there demonstration of any direct communication between abnormal lung and the bronchial tree of the involved lobe. In all instances the vascular anomaly consisted of a pulmonary artery arising from the thoracic aorta or from below the diaphragm.

Three cases were detected as incidental findings on roentgen examination of the chest or in the course of investigation for unrelated complaints. The roentgen appearance in 2 of these (Cases 1 and 2) is thought to be sufficiently characteristic

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Presented before the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

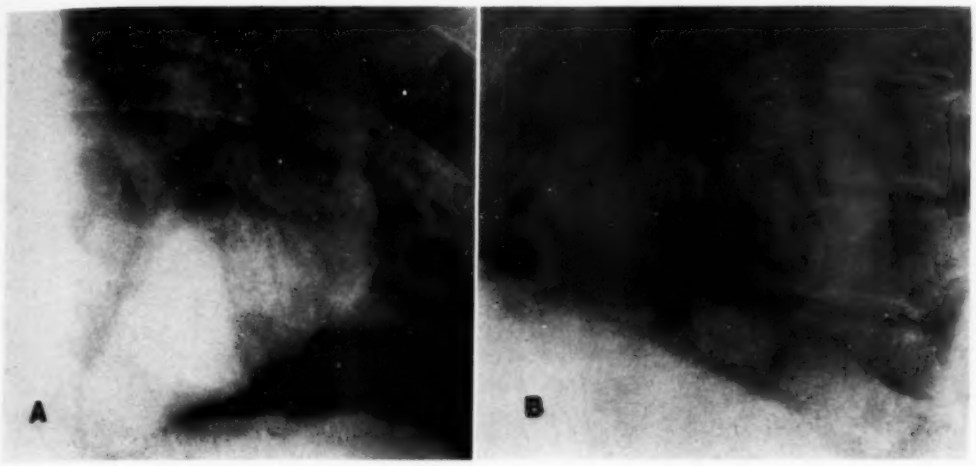

Fig. 1. Case 1. A. Postero-anterior view of a segment of the left lower lung field showing a lobulated mass. A finger-like projection of the tumor extends medially and downward toward the aorta and diaphragm. B. Left lateral projection of the posterior lower chest revealing the location of the lesion.

to suggest the presence of the condition; in the third (Case 3) the appearance is less specific. The other 4 cases presented as problems of infection. In each, except when obscured by adjacent consolidation or pleural effusion, a thin-walled cyst or cysts were seen in the posterior portion of a lower lobe.

CASE REPORTS

CASE 1: A 54-year-old white male entered the hospital on Feb. 21, 1950, for study of an abnormality in the left chest discovered on a routine survey examination. He was asymptomatic, and neither physical examination nor routine laboratory work disclosed any significant abnormality. Bronchoscopy and cytologic study of the sputum were also non-contributory.

Roentgen examination of the chest revealed emphysema and, in the region of the anterior, posterior, and medial basal segments of the left lower lobe, a lobulated, sharply defined, homogeneous tumor (Fig. 1). The emphysema was slightly more pronounced immediately surrounding the mass than elsewhere. The lesion extended to the posterior third of the diaphragm, where it lay close to the spine. A projection extended toward the aorta like a pointing finger, and where this "finger" was in contact with the diaphragm the contour of the latter was obscured. It was thought that the mass might be of vascular origin. As there were no large branches of the left pulmonary artery which appeared to communicate directly with the tumor, it was concluded that the blood supply was probably derived from the aorta rather than the pulmonary artery. The left lung root lay somewhat further laterally than usual.

A *left lower lobectomy* was performed. A well developed interlobar septum, but no accessory fissure, was found. In the lower margin of the pulmonary ligament was a large pulsating artery coming from the aorta and entering the medial surface of the lower lobe inferiorly. Venous drainage was through the normal pulmonary venous system.

Pathologic Examination: An anomalous pulmonary artery measuring 8 mm. in diameter entered the parenchyma at the extreme posterior-inferior medial angle of the left lower lobe. This artery was injected with red contrast material. The basal branch bronchi were all identified and were not abnormal in appearance or arrangement.

On section, a large, irregular, multilocular cyst measuring 9 × 8 × 6 cm. was discovered. The cyst, which was completely embedded in the pulmonary parenchyma, contained two major and many minor pockets which freely communicated and were filled with soft, dirty, yellow-brown mucoid material. The wall was firm and fibrous, averaging 1 mm. in thickness. The anomalous artery ramified extensively over the cyst, to which its distribution appeared to be confined. This artery was found to be atherosclerotic and was of the elastic type characteristic of pulmonary artery.

Microscopic study of the cyst wall showed it to be lined with bronchial epithelium. Immediately adjacent to the wall was a patch of atelectatic lung tissue in which some fibrosis was apparent and at least one area of pneumonitis of the chronic cholesterol type (21). The atelectatic zone was surrounded by emphysematous lung, the degree of emphysema here being somewhat more marked than that noted elsewhere.

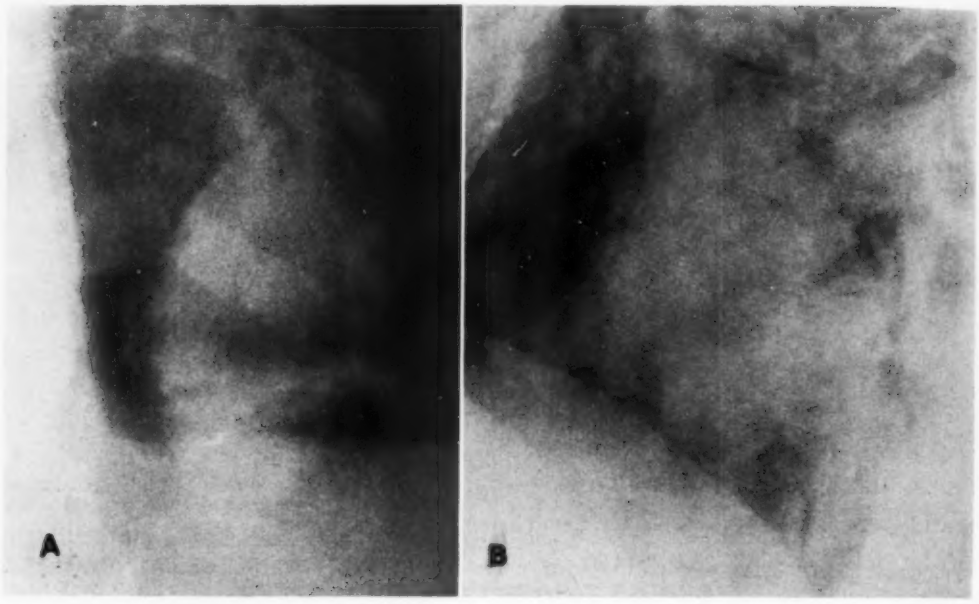

Fig. 2. Case 2. A. Highly penetrated postero-anterior view of the medial portion of the left lower lung field showing the homogeneously dense mass, with a projection of its lower medial aspect directed toward the aorta. B. Lateral film confirming the position of the lesion. There is residual contrast substance in the lungs from examination done at another hospital.

CASE 2: A 27-year-old white male entered the hospital Jan. 1, 1951, because of rather vague complaints of malaise and easy fatigability. Physical examination disclosed nothing remarkable. Routine laboratory studies, bronchoscopy, and bronchography at another hospital were reported as negative.

Roentgen examination of the chest revealed, in the posterior basal region of the left lower lobe, a roughly ovoid, slightly lobulated, homogeneous mass (Fig. 2). Residual contrast substance from the previous bronchographic study was present. The highly penetrated postero-anterior grid film showed the lesion to lie medially and inferiorly in the left chest, with a finger-like projection pointing downward and medially in the direction of the aorta.

In view of the experience in Case 1, in which a lower lobe mass with an inferior finger-like projection had been present, the findings in this patient were interpreted as being due to a congenital cystic anomaly of the lung associated with an abnormal systemic pulmonary artery.

At *thoracotomy*, a large artery arising from the descending aorta and running laterally in the pulmonary ligament was discovered. *Resection of the basal segments of the left lower lobe* was performed.

Pathologic Examination: An irregular, small, partial fissure ran vertically over the lateral and medial surfaces of the basal segments of the left lower lobe, demarcating approximately the posterior fourth of the lung. An artery measuring 5 mm. in diameter entered the inferior medial portion of this fissure. Section of the specimen revealed a multiloculated cyst measuring 5 × 7 cm. which had a smooth lining and contained brown flocculent fluid. Adjacent to this cyst were many thin-walled emphysematous spaces measuring up to 6 mm. in diameter. Contrast substance injected into the posterior basal segmental bronchus entered the fringe of the emphysematous tissue adjacent to the cyst; none entered the cyst. Additional contrast substance injected into the accessory artery filled a network of spaces throughout the sequestered portion and ramified in tiny capillaries for a short distance in the adjacent normal parenchyma. None of this appeared in the cyst. The bronchial tree supplying the basal segments was identified and no abnormality was found.

CASE 3:[2] A 51-year-old white male entered the hospital on Aug. 11, 1943, because of intermittent substernal discomfort, of four years duration. Physical examination was not remarkable and routine laboratory studies were normal. Bronchoscopy was non-contributory.

Roentgen examination of the chest disclosed a rather sharply defined, homogeneous mass behind

[2] Case Report 29401, Massachussetts General Hospital, New England J. Med. **229:** 591-595, 1943. Also reported by Brown and Robbins (5).

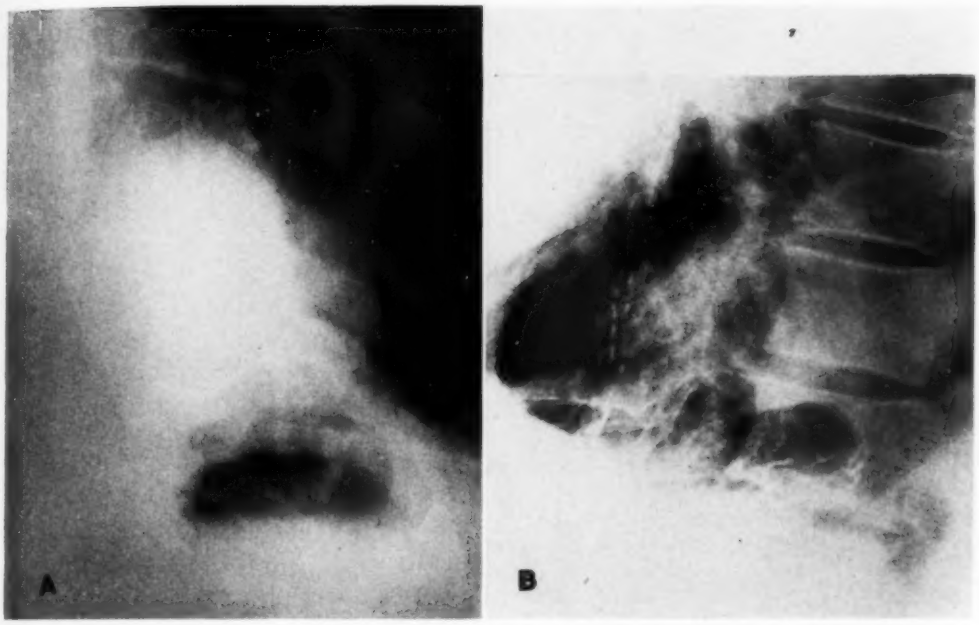

Fig. 3. Case 3. A. Highly penetrated grid film in postero-anterior projection showing the mass in the medial portion of the left lower lobe in immediate contact with the herniated portion of the stomach. B. Left lateral view showing the mass in the lung indenting the herniated fundus of the stomach.

the heart (Fig. 3). The mass, lying medially in the left lower lobe close to the spine, was in immediate contact with and deformed a portion of the stomach which had herniated through the diaphragm. The esophagus was contiguous to the mass anteriorly and medially.

At *operation*, the *diaphragmatic hernia was repaired* and a segmental left lower lobectomy was carried out. On separating the lung from the diaphragm, the mass was discovered in the medial aspect of the basal segments of the left lower lobe. There were two vessels, one measuring about 2 mm. in diameter and the other about 5 mm., running from the cystic area in the lung through the diaphragm between the hernia and the esophageal hiatus.

Pathologic Examination: The specimen consisted of the basal segments of the left lower lobe. At the medial-inferior margin of the specimen, an artery measuring 4 mm. in diameter and entering the lung was identified. On section, a large cystic cavity, $8 \times 5 \times 3$ cm., was found very close to the pleural surface on the medial, posterior, and inferior aspect. The cyst contained inspissated homogeneous, gelatin-like material. The inner lining of the cyst was glistening, pearly-gray to pink, with fibrous trabeculae coursing across it. No communication with a bronchus was demonstrated. The cyst wall averaged 0.5 mm. in thickness and consisted of bronchial epithelium and in some places cartilage.

CASE 4:[3] A 15-year-old-boy entered the hospital on May 15, 1949, because of a febrile illness of four weeks duration, characterized by general malaise, mild headache, lack of strength, and temperature rising to 101°. Penicillin and Aureomycin had been administered three and two weeks prior to admission.

Abnormal physical findings on admission were limited to dullness over the right chest posteriorly, extending up to the lower border of the scapula, numerous moist râles, and increased whispered pectoriloquy over the right base posteriorly. The white blood cell count was 11,400 with 69 per cent polymorphonuclear leukocytes. Bacteriologic studies were non-contributory.

Roentgen examination of the chest on the third hospital day showed diffuse hazy density in the right lower lobe, with three distinct air- and fluid-containing cavities (Fig. 4). The process appeared to be localized to the posterior basal, superior, and subsuperior regions.

During the period of observation this portion of the right lower lobe became smaller, but the three thin-walled cysts persisted.

The bronchoscopist suggested that, because of absence of a significant quantity of secretion in the right lower lobe bronchus, the process might be

[3] Case Report 36361, Massachusetts General Hospital, New England J. Med. **243:** 383-387, 1950.

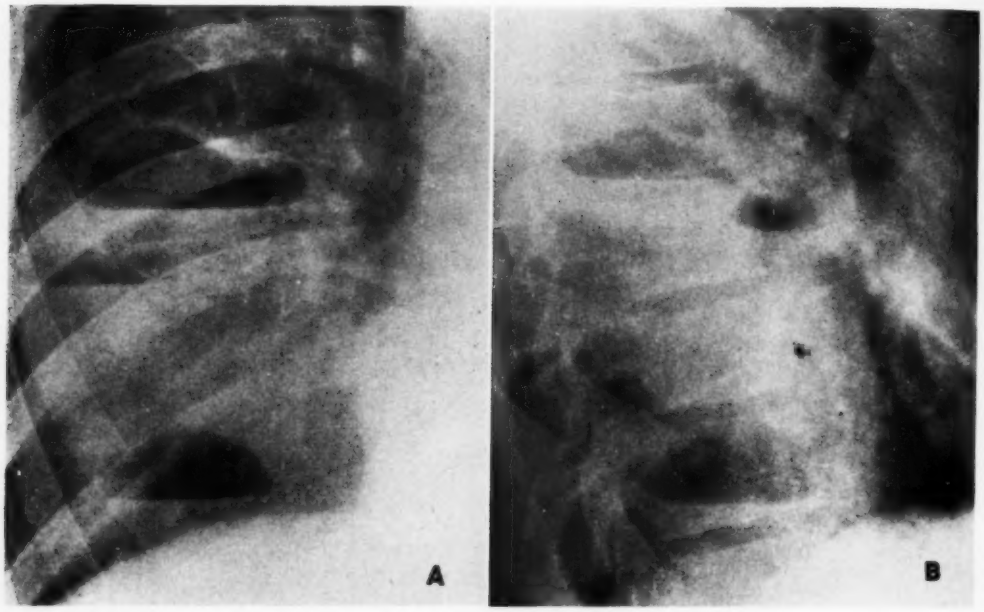

Fig. 4. Case 4. A. Postero-anterior projection of the right lower chest showing air and fluid in at least three thin-walled cystic cavities surrounded by pneumonitis. B. Lateral projection showing the posterior location of the cavities in the right lower lobe.

superimposed upon congenital cysts which did not communicate with the bronchi rather than upon freely connected, typical lung abscesses.

After two days of chemotherapy the patient became afebrile, and on the tenth hospital day he was discharged improved.

The second admission was almost one year later, April 10, 1950. In the interim the patient had felt relatively well until three weeks prior to re-entry, when an upper respiratory infection developed, with malaise and a low-grade fever.

The physical findings were essentially unchanged from those on the first admission. The temperature rose to 103° on the second hospital day but fell promptly with the administration of antibiotics.

Roentgen examination of the chest on the third hospital day showed practically the same appearance as the original roentgenograms, except that the consolidation, though confined to the same regions, was more extensive and the cysts were less clearly visible (Fig. 5).

One month later, examination showed the involved portion of the right lower lobe to be reduced in size; linear densities were seen lying posteriorly and medially. The three cysts which had been observed previously could not be identified with certainty because they no longer contained fluid and the adjacent lung was aerated.

Right lower lobectomy disclosed many cystic lesions throughout the entire posterior portions of the right lower lobe, from the apex to the base. A large anomalous pulmonary artery was discovered arising from the descending aorta about one inch above the diaphragm and extending into the cystic region of the lung. This artery was almost the size of a lead pencil in diameter.

Pathologic Examination: A deep abnormal fissure was seen on the lateral, inferior, and medial aspects of the lung, partially separating the posterior from the anterior portions. A large aberrant artery entered the lung on its posteromedial-inferior aspect. Red latex solution was injected into this vessel under low pressure. The solution appeared in a large artery at the hilus and filled vessels ramifying over the involved segments, which contained innumerable thin-walled cysts. Injection of the large hilar vein demonstrated that venous return from the abnormal region was to a pulmonary vein. The usual branch bronchi were identified, but no gross communication with the cysts was found.

CASE 5: A 33-year-old white woman was admitted to the hospital on Oct. 22, 1944, complaining of chest pain, exhaustion, and a high fever.

Three weeks before admission she had noted the onset of pain in the left chest, with fever reaching as high as 103°. For two weeks before entry she had received sulfadiazine, and for one week penicillin. A thoracentesis had yielded brown fluid.

Physical examination was non-contributory ex-

cept for the findings in the chest. These consisted of dullness to percussion, most marked at the left base, and amphoric breath sounds superiorly which diminished until there was almost complete absence of breath sounds at the left base posteriorly. The temperature was 105°, respirations 38, pulse 120; the white blood count was 11,900, red blood cells 3,100,000, and hemoglobin 9.7 gm. per cent.

cavity through this tube, outlined a lobulated thin-walled cyst approximately 8 cm. in diameter. Contrast substance failed to enter the bronchi.

On Sept. 13, 1946, the patient was readmitted for definitive surgery. Roentgen examination showed persistence of the thin-walled cyst in the left lower lobe medially and posteriorly.

Thoracotomy disclosed the cyst. The left lung

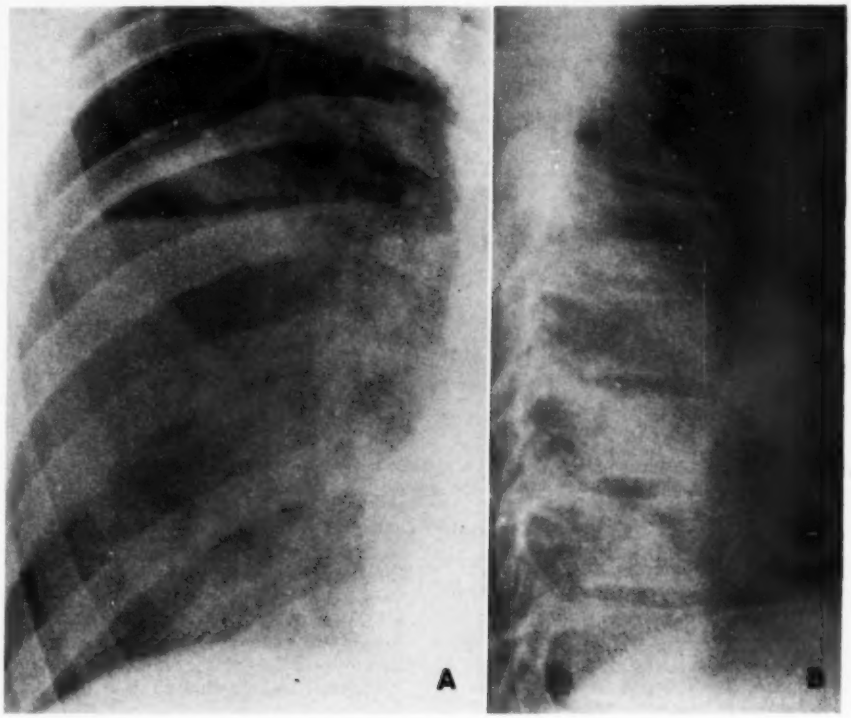

Fig. 5. Case 4. A. One year later recurrent infection involves the same area in the right lower lobe. The cysts are again apparent, though the lower ones are less easily seen. B. Lateral view showing the disease involving the same area of lung.

Roentgen examination of the chest on the day of admission showed a large quantity of fluid in the left pleural space, displacing the heart and mediastinum toward the right and compressing the lung. Small gas bubbles in the left pleural space were the result of previous chest taps. The presumptive diagnosis at this time was empyema, and possibly an underlying lung abscess.

The day after admission, needle aspiration was followed by a trocar thoracotomy. The fluid withdrawn was reddish-gray and gelatinous; bacteriologic studies were non-contributory.

Three weeks later drainage of the left chest by rib resection was done. The patient became afebrile and was discharged improved, with the drainage tube maintained in the left chest.

One year later, radiopaque oil, introduced into the

displayed no true fissures, there being only one rudimentary fissure extending for a distance of about 4 cm. along the anterior portion of the cyst. An abnormal pulmonary artery, measuring 4 mm. in diameter, was found arising from the descending thoracic aorta about 8 cm. above the diaphragm, disappearing into the cystic region of the left lower lobe. *Segmental resection* of the cyst-bearing portion of the lobe was carried out; a sizable vein leading from this portion of the lung to the inferior pulmonary vein was cut and ligated.

Pathologic Examination: Section of the specimen, which exhibited a rough external surface with numerous fibrous tags, disclosed a fully epithelialized, smooth-walled, somewhat trabeculated cyst measuring 7 cm. in its greatest diameter, surrounded by a 2 to 4 mm. zone of atelectatic lung.

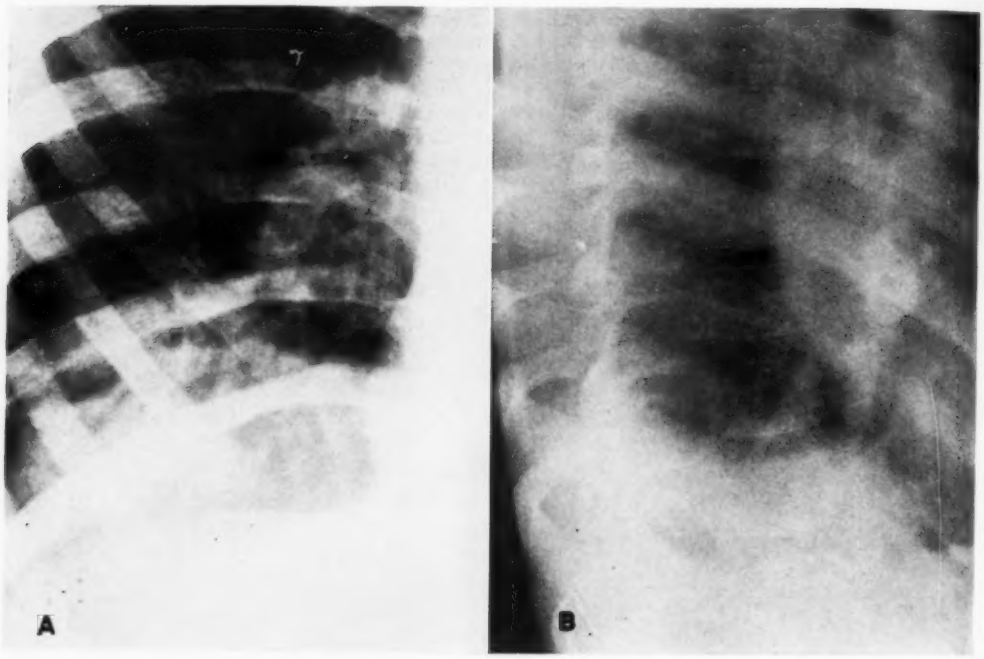

Fig. 6. Case 6. A. Postero-anterior view of the right lower lung field showing the cystic cavities, surrounding pneumonitis, and enlarged lymph nodes in the right hilus. B. Lateral view showing the posterior position of the process and the enlarged nodes.

CASE 6: A 5-year-old white male was brought to the hospital on April 26, 1943, because of cough, fever, and coryza of six weeks duration. The child had been born normally at term. During a five-day period beginning ten days after birth, he had had four transient episodes of cyanosis, lasting one or two minutes. Roentgen examination of the chest at the age of seven weeks had been thought to show an enlarged thymus or collapse of the right upper lobe. There had been no further episodes of cyanosis, but breathing had seemed to be unusually noisy. Growth and development had been normal.

Six weeks prior to entry, afternoon fever up to 103° had developed, with cough and coryza, and the child had become lethargic. After two weeks illness, he was admitted to another hospital, with a temperature of 102.4°, pulse 140, and respirations 44. The chest showed dullness to percussion and distant sounds in the lower portion of the right lung posteriorly. The white blood count was 12,000 and hemoglobin 85 per cent. Improvement was obtained on sulfathiazole therapy. Two weeks later the fever recurred but responded to sulfadiazine. Roentgen examination of the chest revealed a triangular area of density in the right apex and a mottled area of increased density at the right base, within which were cystic areas of decreased density.

At this time all the roentgenograms made in the past, including those taken at the age of seven weeks, were reviewed, and it was decided that on each occasion cystic areas had been present in the same portion of the right lower lobe. The patient was referred to this hospital for further study.

Physical examination showed a well developed, fairly well nourished boy weighing 40 pounds. Temperature was 100.6°, pulse 86, and respirations 22. There was splinting of the right chest, with dullness and flatness to percussion posteriorly and absence of breath sounds at the base. The white blood count was 20,800, with 74 per cent polymorphonuclear leukocytes; hemoglobin was 9.8 mg. per cent.

Roentgen examination of the chest showed an area of consolidation involving the posterior-inferior portion of the right lower lobe (Fig. 6). Within the upper portion of the consolidation were a number of cystic cavities containing fluid and air. There was considerable enlargement of the lymph nodes in the right lung root and mediastinum. The appearance of the rest of the chest was not unusual.

After a week in the hospital, the patient was discharged to await further subsidence of the acute phase of the infection before surgical resection of the involved area of lung was undertaken. Roentgenograms made at the time of discharge showed no appreciable change.

Seven weeks later re-examination of the chest demonstrated persistence of the consolidation in the right lower lobe, the cystic cavities, and the enlargement of lymph nodes. The patient was therefore admitted to the hospital, and a *right lower lobectomy* was performed.

At thoracotomy, marked consolidation of the lower lobe, except for its superior segment, which appeared well aerated, was evident. In the edge of the pulmonary ligament there was a large aberrant artery which pulsated freely. This artery came up from below the diaphragm and entered the right lower lobe.

Pathologic Examination: In the inferior portion of the pulmonary ligament of the resected right lower lobe was an anomalous artery 3 mm. in diameter. The lower third of the lobe was consolidated. The lesion was sharply demarcated from the normal lung and consisted of a honeycomb of cystic spaces varying from 1 mm. to 2 cm. in diameter. The cysts were filled with inspissated homogeneous yellow material and lay in a bed of fibrous tissue diffusely and thickly marked by brilliant golden-yellow areas.

Microscopic study disclosed areas where the mucosa lining the cysts had been destroyed by the inflammatory process. The intervening parenchyma contained scattered alveoli, some epithelialized and some holding large foamy mononuclear cells filled with lipoid, typical of the cholesterol type of pneumonia.

CASE 7: The patient, a white male of 15 years, was first seen in October 1936 because of pain in his left chest and left upper abdomen. He had had three previous attacks of pleurisy and fever of short duration. Physical examination disclosed dullness, distant breath sounds, diminished fremitus, and a high diaphragm at the left base posteriorly.

Roentgen examination of the chest showed sharply demarcated consolidation confined to the left lower lobe. The left interlobar artery and its branches lay further laterally than usual.

Following discharge from the hospital the patient continued to have recurrent attacks of pleurisy and fever until the fall of 1939, when he went to Colorado. Before his departure, re-examination of the chest showed a cyst-like cavity in the left lower lung field. This was described as being completely empty and having a thin wall.

In 1942, a few months after his return to Boston, he had another respiratory infection, which was followed by a chronic cough productive of thick, yellowish-green, foul sputum in amounts up to 2 ounces daily.

Physical examination and laboratory studies on readmission to the hospital were essentially unchanged from those recorded at the previous hospitalization.

On the third hospital day, *resection of the basal segments of the left lower lobe* was done. An almost complete fissure was found separating the posteromedial portion from the remainder of the left lower lobe. An anomalous pulmonary artery measuring 4 mm. in diameter extended from the aorta above the diaphragm at the level of the eleventh rib to the involved portion of the left lower lobe.

Pathologic Examination: Section of the specimen showed a multilocular cyst measuring 7 × 5 × 6 cm. and containing purulent material. Entering the medial aspect of the specimen in close relation to the cyst wall was an artery which measured approximately 5 mm. in diameter.

DISCUSSION

Sequestration of the lung of the intralobar type associated with an anomalous pulmonary artery from the aorta or one of its abdominal branches may manifest itself in one of two ways. The lesion may be detected as an incidental finding in a radiographic examination of the chest or it may present a picture of chronic infection recurring in the same location in a lung. In the present series, 3 cases fell into the former category while 4 were of the latter type.

The group in which the condition was detected largely or entirely as an incidental finding presented radiographic changes which are best described as sharply outlined homogeneous masses. These masses always involved the posterior, medial, and inferior portion of a lower lobe and extended in varying degree into adjacent areas. The distribution of the lesions was not segmental. In 2 of the cases, an unusual finger-like projection from the mass was directed medially and downward toward the aorta, where it pierced the diaphragm.

In the 4 cases in which infection played a predominant part there were times when the cyst or cysts were plainly visible and other times when surrounding consolidation in the adjacent lung obscured them. Both fluid and air were seen in these cavities, and the walls, when well visualized, were usually very thin. When opportunity for observation over a period of years was possible, as in the last 4 cases, it was apparent that each recurrence of the disease process involved the same portions of the lobe. This was particularly true in Case 4, in which the same number

of cysts with clearly defined fluid- and air-filled cavities appeared and disappeared at various times, always in the same portion of the right lower lobe.

No unusual roentgen technic is required to demonstrate sequestration of the lung associated with anomalous systemic pulmonary artery. The most valuable films have proved to be those taken in the postero-anterior projection with heavy penetration, with a grid or Potter-Bucky diaphragm.

Differential diagnosis must include the large number of lesions which may arise in the lung, mediastinum, or chest wall, as well as diaphragmatic hernia. In those instances in which infection plays a predominant part various types of acute and chronic inflammatory disease must be considered. In these, bronchoscopy may have value in differentiating the condition because the expected secretion or reaction in the bronchi directed toward the involved portion of the lung is absent. Moreover, the systemic reaction of the patient seems to be less violent than would be anticipated from the extent of the pulmonary consolidation observed radiographically.

In cases which show large thin-walled cysts in the involved area, and especially when the process recurs repeatedly in similar fashion, sequestration should be strongly suspected. When the lesion presents as a mass from the lower aspect of which a finger-like appendage extends toward the aorta, the diagnosis of sequestration of the lung should be given primary consideration, although other conditions could produce a similar appearance.

Further study by means of aortography might be of value. This might establish the existence of the abnormal pulmonary artery arising from the aorta as diagnostic confirmation in cases in which pulmonary sequestration was suspected.

SUMMARY

1. During the course of embryologic development, an anomalous pulmonary artery arising from the aorta or one of its main branches may be formed and supply a part of the posterior portion of one of the lower lobes. Often some or all of the lung so supplied is cystic and not normally connected to the bronchial tree. This has been called by previous authors "intralobar sequestration of lung." Diaphragmatic hernia is frequently associated with the condition.

2. Seven surgically and pathologically proved cases of this developmental anomaly are described. The condition presented as two distinct clinical problems: (*a*) an asymptomatic lesion incidentally discovered; (*b*) recurrent lower lobe infection.

3. The distinguishing roentgenologic features of the entity are: (*a*) in the asymptomatic patients, a mass-like lesion in a lower lobe, from which a tapering projection may be directed toward the aorta; (*b*) in those with infection as the outstanding feature, a thin-walled cyst or cysts in the posterior basal portion of a lower lobe, often associated with or even obscured at times by infection which may be recurrent.

4. Roentgen recognition of the condition is important in order to avoid the danger of inadvertent section of a large artery in an unexpected location during surgery.

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SUMARIO

Arteria Pulmonar Anómala Procedente de la Aorta y Unida a Quistes Intrapulmonares (Secuestración Intralobular del Pulmón). Reconocimiento Roentgenológico y Significación Clínica de la Misma

Durante la evolución del desarrollo embriológico, puede formarse de la aorta o de una de las principales ramas de ésta una arteria pulmonar anómala que riegue parte de la porción posterior de uno de los lóbulos inferiores. A menudo parte del pulmón así servido o todo el órgano se enquista y no está unido normalmente al árbol bronquial. Este fenómeno ha sido llamado por autores anteriores "secuestración intralobular del pulmón." La hernia diafragmática se asocia frecuentemente con dicho estado.

Descríbense 7 casos comprobados quirúrgica y anatomopatológicamente de ese vicio del desarrollo. El estado encierra dos problemas clínicos distintos: (a) lesión asintomática descubierta fortuitamente; (b) infección recurrente del lóbulo inferior.

Las características roentgenológicas que distinguen a la entidad son: (a) en los enfermos asintomáticos, una lesión abultada en un lóbulo inferior, de la cual se dirige una proyección cónica hacia la aorta; (b) en aquellos en que la infección representa la característica sobresaliente, quiste o quistes de paredes delgadas en la porción basal posterior de un lóbulo inferior, a menudo asociada a, y a veces hasta eclipsada por, infección que puede ser recurrente.

El reconocimiento roentgenológico del estado es importante a fin de evitar el peligro de cortar por inadvertencia una arteria grande en un sitio inesperado al operar.

Bronchial Rearrangement and Bronchiectasis Following Pulmonary Resection[1]

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A THOROUGH knowledge of bronchial anatomy is a prerequisite for proper diagnosis and localization of pulmonary lesions. Advances in thoracic surgery in recent years have stimulated the publication of numerous detailed studies of the bronchial anatomy and its variations (1, 5, 6, 8, 30); as yet, however, there has been no over-all survey of bronchial distribution after pulmonary resection. The need for such a survey became apparent to us when we encountered difficulties in reviewing a series of postoperative bronchograms. We found that individual bronchial identification was not always clear and that the causes of postoperative bronchiectasis, which occurred in some cases and not in others, were not immediately apparent. We therefore studied our bronchographic material with the following questions in mind:

1. Is there a definite and predictable pattern of spatial bronchial rearrangement following segmental resection or lobectomy?
2. If so, what factors prevent or modify such rearrangement?
3. Does bronchial rearrangement contribute to the progression or the development of bronchiectasis in the remaining bronchi?

MATERIAL AND METHODS

An initial survey was made of all cases with multiple bronchograms in which segmental resection or lobectomy had been performed. From these were selected only those in which the bronchial tree was adequately outlined on preoperative and postoperative bronchograms. This gave us a series of 25 cases in which a total of 37 resections had been carried out, as follows:

Resection	Cases
Right upper lobe	2
Left upper lobe	1
Right middle lobe	7
Lingula	2
Right lower lobe	2
Left lower lobe	8
Basal segments of right lower lobe	1
Superior segment of left lower lobe	1
Basal segments of left lower lobe	2
Right middle lobe and right lower lobe	5*
Lingula and left lower lobe	1
Right middle lobe and basal segments of right lower lobe	2
Lingula and basal segments of left lower lobe	3

* In one of these cases the anterior segment of the upper lobe was also resected.

Twenty-three of the patients had been operated on because of bronchiectasis; 1 because of cystic disease; and 1 because of lung abscess.

Postoperative bronchograms had been obtained at intervals ranging from three months to ten years. In some instances serial studies had been made at various times.

We have used the bronchial nomenclature of Jackson and Huber (16), and considered as our basis of reference the normal bronchial anatomic patterns as defined by Boyden (5). Postoperative bronchograms which showed the most marked and typical changes have been selected for reproduc-

[1] From the Departments of Radiology and Surgery, Tufts College Medical School and New England Center Hospital, Boston, Mass. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

tion. Most of the films are in the postero-anterior projection, oblique or lateral films being used only to clarify specific points. Preoperative bronchograms will not be reproduced unless specifically required in the discussion. In our case analyses, we have attempted to compare bronchial redistribution on the right and left sides.

Difficulty in localizing and identifying individual bronchial branches arose from the following factors, occurring singly or in combination: (*a*) technically poor or incomplete preoperative bronchograms available for comparison; (*b*) postoperative changes in bronchiai caliber and position.

The great importance of obtaining complete and optimal bronchograms both before and after operation cannot be overemphasized. The bronchial distribution before operation can thus be noted and the total extent of bronchiectasis accurately judged. The postoperative bronchograms will show whether all of the diseased segments were removed, whether there is progression or new development of bronchiectasis, and what the spatial bronchial redistribution is.

The particular technic of introducing the opaque medium is not of primary importance, provided a minimum of five films is obtained: postero-anterior and lateral films after initial filling of one side, usually the side considered to have the major or only involvement, and postero-anterior and both oblique films following filling of the opposite side. Particular attention should be paid to the effect of anatomic bronchial variation as well as of preoperative atelectasis and pleural involvement upon bronchial redistribution.

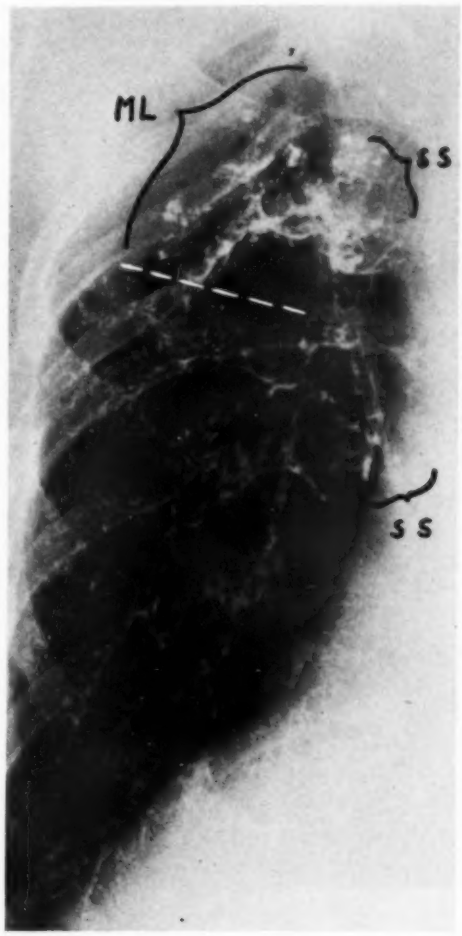

Fig. 1. Right upper lobectomy. Postero-anterior bronchogram, four years postoperatively. The middle lobe bronchi have shifted into the upper lobe area. M.L. Middle lobe bronchi. SS. Superior segmental bronchi of lower lobe. The basal segmental bronchi of the lower lobe lie below the interrupted white line.

SPATIAL BRONCHIAL REARRANGEMENT

Right Upper Lobectomy (2 Cases): The bronchial rearrangement in 2 cases in which right upper lobectomy had been performed revealed essentially identical patterns, varying only in degree (Figs. 1 and 2). The middle lobe bronchi swung upward and backward into the area of the resected upper lobe. The basal bronchi of the lower lobe fanned out as this lobe expanded to fill the space previously occupied by the middle lobe. Identification of the three branches of the superior segment was difficult in one case; in the other, a slight clockwise upward rotation of two subsegmental bronchi of the superior segment took place. They could be seen only in the left anterior oblique view (not illustrated). Di Rienzo (7) reports a similar bronchial rearrangement.

No case of resection of the anterior and apical-posterior segments of the left upper

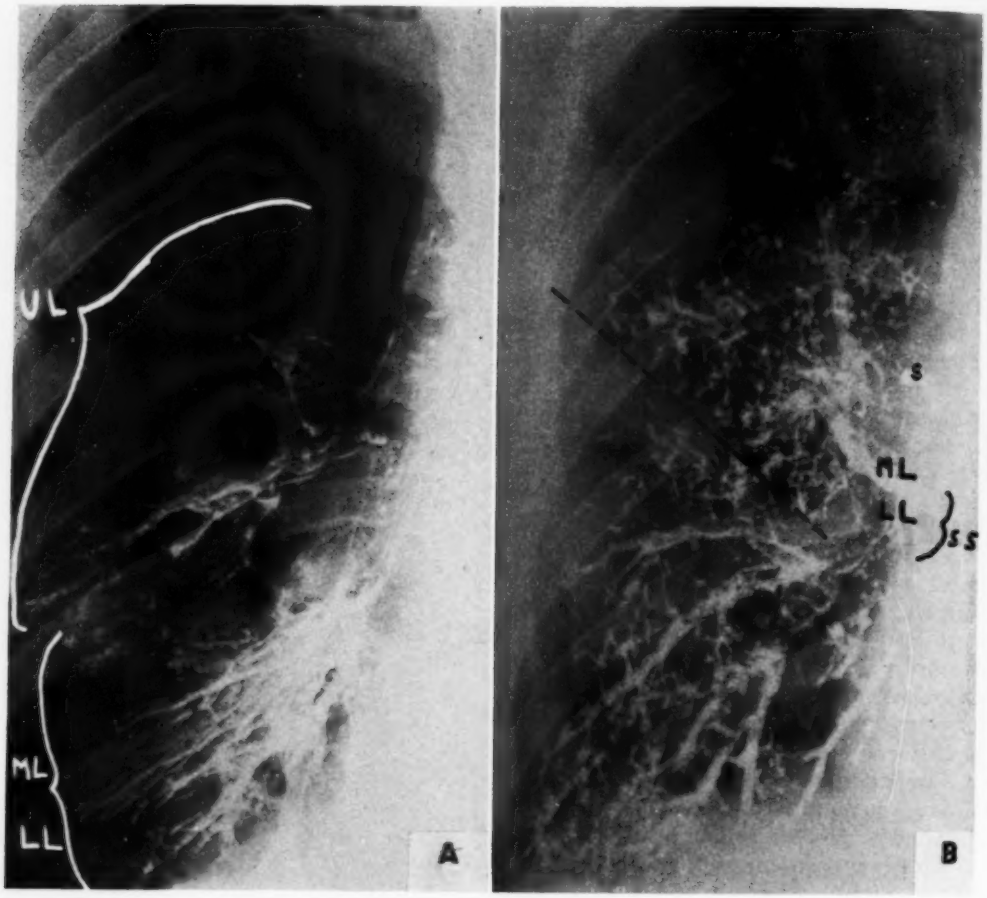

Fig. 2. A. Preoperative postero-anterior bronchogram showing severe emphysema of the upper lobe, with crowding and downward displacement of the middle and lower lobe bronchi. UL. Upper lobe bronchi. ML and LL. Middle and lower lobe bronchi.

B. Following right upper lobectomy. Postero-anterior bronchogram eight months postoperatively. Right upper lobe specimen showed advanced cystic disease. "Open fan" appearance of remaining bronchi. The middle lobe bronchus has changed its take-off angle 90 degrees as compared to the preoperative finding (A). S. Stump of resected right upper lobe bronchus. ML. Middle lobe bronchus. LL. Lower lobe bronchus. SS. Superior segmental bronchi of lower lobe. The interrupted black line separates the middle lobe bronchi from those of the lower lobe.

lobe was available for comparison and we can therefore assume only that the lingular bronchi would undergo changes similar to those noted in the middle lobe bronchi.

Left Upper Lobectomy (1 Case): The postoperative bronchogram in the 1 case of left upper lobe lobectomy showed a shift of the bronchi of the superior segment of the lower lobe anteriorly and upward into the region of the resected upper lobe (Fig. 3). There was concurrent but less marked upward and lateral shift of the basal bronchi of the lower lobe. Owing to this rearrangement, the left main bronchus was elevated, subsequently bringing about a marked change in the "take-off" angle of the left lower major bronchus, which followed an abruptly downward course.

The analogous anatomic configuration would make comparison of this case with cases of combined right upper and middle lobe resection valuable, but no postoperative bronchograms were available in these cases.

In comparing bronchograms after left and right upper lobectomy (Figs. 1 and 2), it is apparent that, on the right side, the middle lobe bronchi undergo the major readjustment following resection of the upper lobe; on the left, the major readjustment is made by the superior segmental bronchi of the lower lobe, although not all of the three branches of the superior segmental bronchus (Fig. 3) show the same degree of displacement.

Right Middle Lobectomy (7 Cases); Lingulectomy (2 Cases); Resection of Superior Segment of Left Lower Lobe (1 Case): No striking evidence of rearrangement of the major bronchial branches was noted in the postoperative bronchograms in cases in which right middle lobectomy, lingulectomy, or resection of the superior segment of the left lower lobe was performed. This was to be expected, considering the small volume of lung removed.

Right Lower Lobectomy (2 Cases): The bronchial rearrangement noted in 1 of 2 patients following right lower lobectomy (Figs. 4A and B) consisted of a marked downward and posterior fanning-out of the middle lobe bronchi. These bronchi filled the entire anteroposterior diameter of the lower one-third of the right chest cavity; the anterior bronchial branches of the upper lobe descended only slightly. As a result of the shrunken bronchiectatic lower lobe, some spreading and downward shift of the middle lobe bronchial branches were already evident in the preoperative bronchogram.

In the other case (Fig. 5), no spreading of the middle lobe bronchi took place. In this instance, the right middle lobe showed some evidence of pre-existing bronchiectasis, which progressed as a result of postoperative complications.

It is interesting that, although postoperative complications (bronchopleural fistula and empyema) occurred in both cases, bronchial rearrangement was prevented in only 1 case.

A comparison of bronchograms after right upper lobe and right lower lobe resection (Figs. 1 and 4) graphically illustrates the remarkable range of motion of which the middle lobe bronchi are capable.

Fig. 3. Left upper lobectomy. Right anterior oblique bronchogram fifteen months postoperatively. Two major bronchial branches of the superior segment (SS, white) have swung into the area of the resected upper lobe. BS. Basal segments of left lower lobe. Remaining superior segmental bronchi (SS, black) not notably shifted.

Left Lower Lobectomy (8 Cases): In 6 cases, the bronchial redistribution following left lower lobectomy was uniform (Fig. 6). In one of the remaining cases, the degree of shift was diminished by postoperative complications, and in the other by a two-stage operation.

The principal rearrangement was a downward, medial, and posterior shift of the lingular bronchi with "kneeling" of the terminal ramifications in 4 cases. Less marked was a shift of the anterior seg-

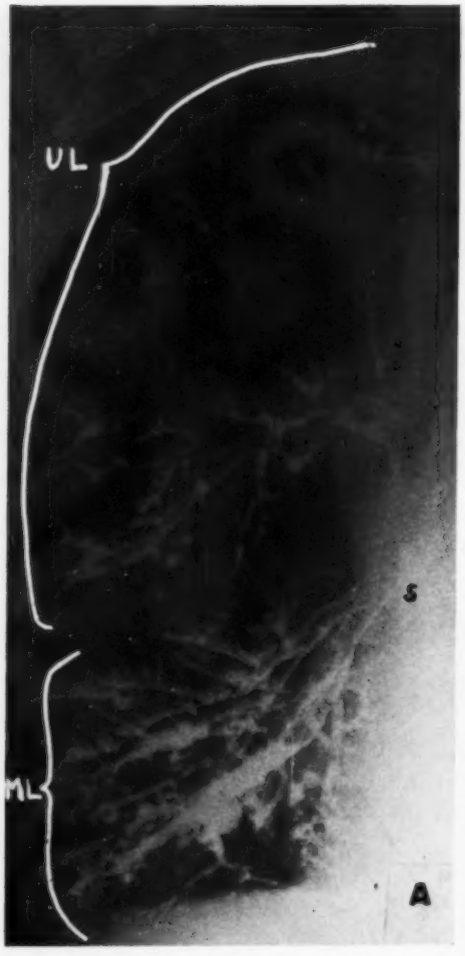

Fig. 4A. Right lower lobectomy. Postero-anterior bronchogram two years postoperatively. UL. Upper lobe bronchi. ML. Middle lobe bronchi. S. Stump of resected lower lobe.

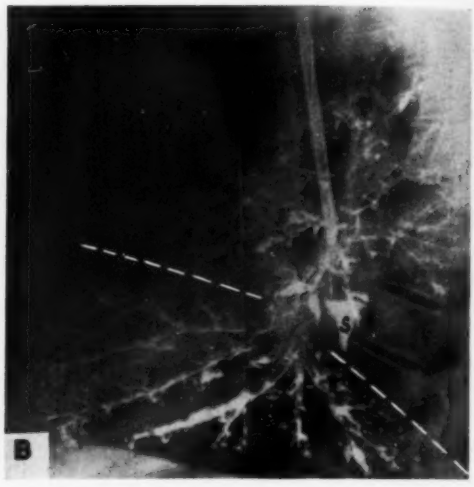

Fig 4B. Lateral view of case shown in Fig. 4A. Marked posterior spreading of middle lobe bronchi occupying major area of resected lower lobe.

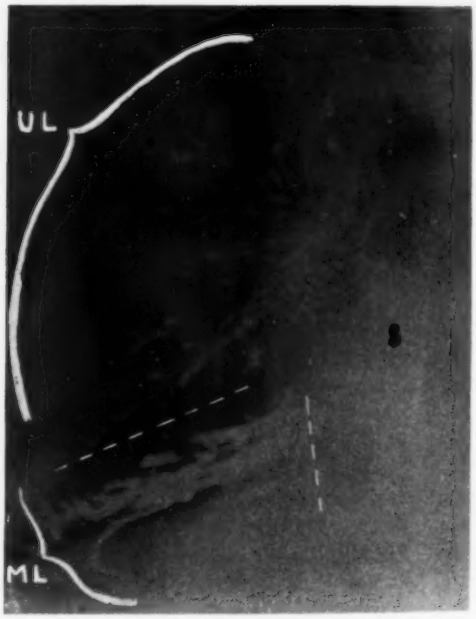

Fig. 5. Right lower lobectomy. Left anterior oblique bronchogram four years postoperatively. UL. Upper lobe bronchi. ML. Middle lobe bronchi. S. Stump of resected lower lobe. Marked crowding of bronchiectatic middle lobe bronchi that do not spread posteriorly. Compare with Fig. 4A.

mental bronchi downward and medially.

In the case showing the most marked postoperative bronchial rearrangement (Fig. 6A and B), the major lingular bronchus extended downward at a right angle from the intermediate upper lobe bronchus, perpendicular to the plane of the diaphragm, terminating in the lowest cardiophrenic area. Also marked was the downward and medial shift of the anterior segmental bronchi.

Comparison of the bronchial changes following resection of the lower lobe on either side (Figs. 4 and 6) reveals in each instance an essentially similar directional

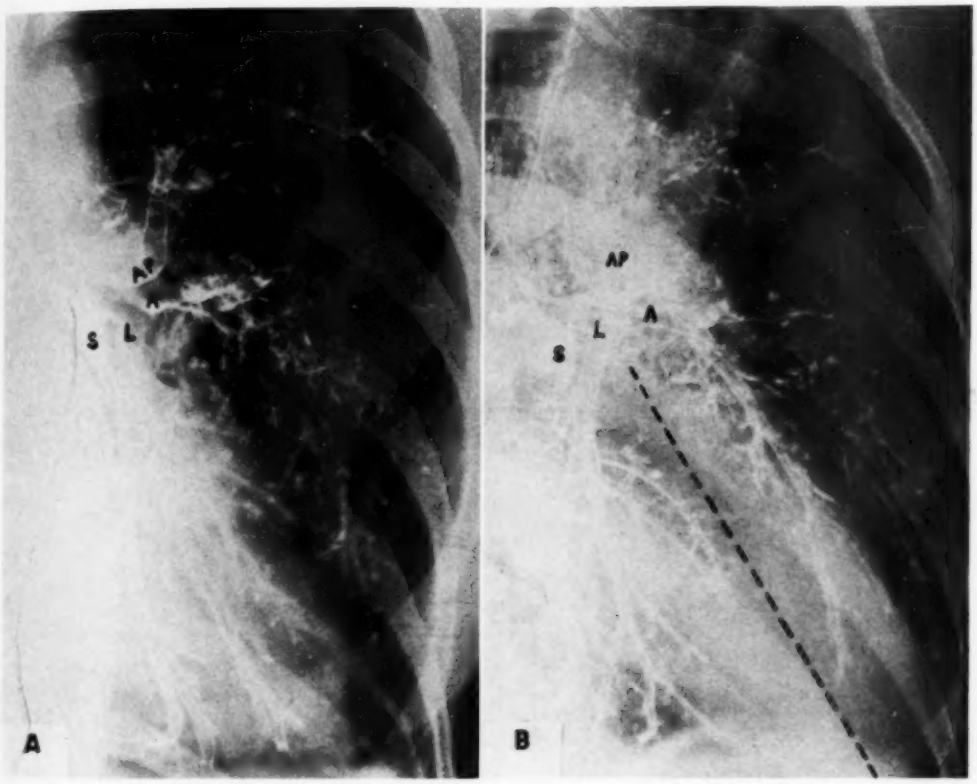

Fig. 6. Left lower lobectomy. A. Postero-anterior bronchogram five years postoperatively. Distribution of lingular bronchi behind the heart shadow, with "take-off" angle of 90 degrees from the intermediate upper lobe bronchus.

B. Right anterior oblique bronchogram showing posterior shift of lingular bronchi to better advantage. AP. Apical posterior segmental bronchus. A. Anterior segmental bronchus. L. Lingular bronchus. S. Lower lobe stump.

shift of the remainder of the bronchial tree. This was to be expected in view of the analogous nature of the right middle lobe and the lingula of the left upper lobe. The extent of the shift is more marked on the left, however, possibly because the lingular bronchus arises from the upper lobe bronchus on the left at a higher level than that at which the middle lobe bronchus arises from the intermediate bronchus on the right. "Kneeling" of the terminal branches was associated with the increased degree of shift required on the left. This "kneeling" phenomenon was also noted following resection of either the basal segments of the left lower lobe alone or the lingula and basal segments of the left lower lobe together. It was present after resection of the right middle and lower lobes, but was not observed after right lower lobectomy alone.

Right Middle and Lower Lobectomy (5 Cases): All of the cases in which right middle and lower lobectomy were done showed a similar spatial bronchial rearrangement (Fig. 7A), modified in individual instances by phrenic paralysis or other postoperative complications.

The adjusting bronchial shift involved primarily the anterior segmental bronchi of the upper lobe, which moved downward, medially, and posteriorly, ultimately bringing their axes into a line almost perpendicular to the plane of the diaphragm, with the terminal bronchi in the lowest cardiophrenic area. Some of the terminal bron-

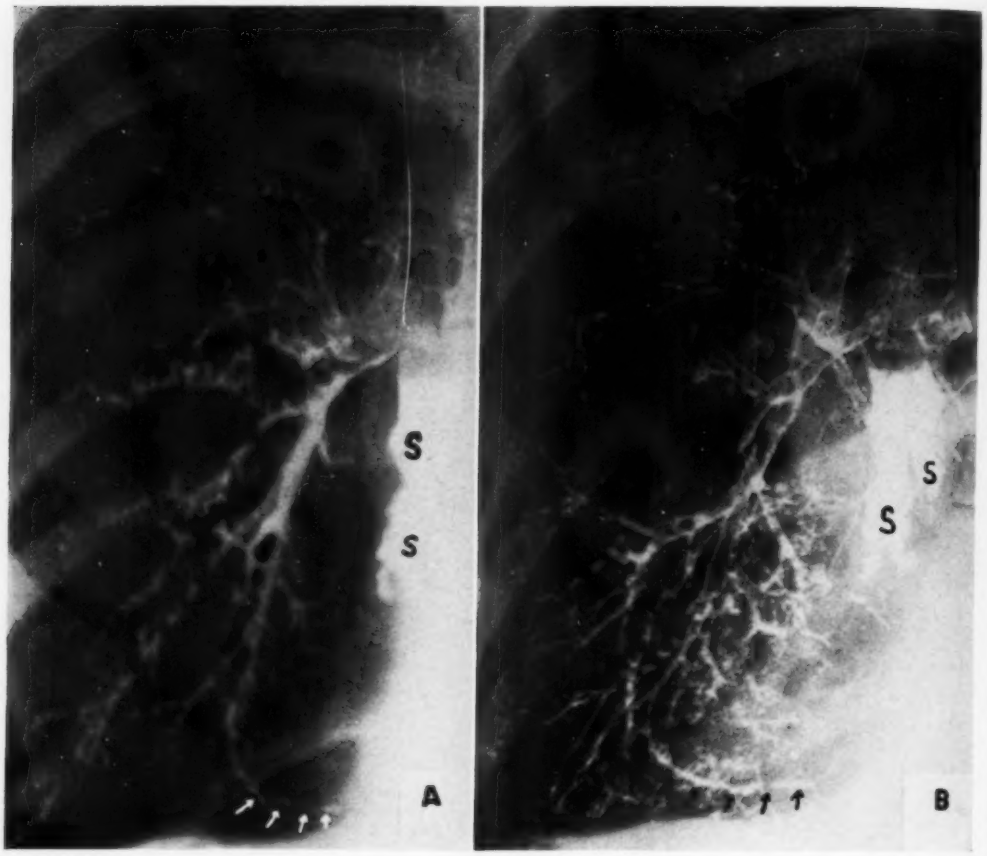

Fig. 7. Right middle and lower lobectomy. A. Postero-anterior bronchogram three and a half years postoperatively. Downward course of anterior segmental bronchi of upper lobe, with marked change in take-off angle and "kneeling" of terminal branch. S. Stumps of middle and lower lobe major bronchi. All bronchi visualized are those of the upper lobe. White arrows indicate "kneeling" terminal bronchus.
B. Left anterior oblique bronchogram showing to better advantage the "kneeling" of terminal bronchus of the anterior segment (black arrows).

chi curved backwards in a "kneeling" configuration, parallel to and almost touching the diaphragm (Fig. 7B). The remaining bronchial branches of the upper lobe moved only slightly downward and medially.

In 1 case, preoperative bronchography showed that a similar but less marked bronchial shift, secondary to marked atelectatic and fibrotic contraction of the bronchiectatic middle and lower lobes, had already taken place. Following operation, during which the phrenic nerve was severed, the right hemidiaphragm was elevated and the size of the hemithorax was reduced, apparently preventing further bronchial rearrangement.[2]

Lingulectomy and Left Lower Lobectomy (1 Case): In 1 case, left lower lobectomy was followed two years later by lingulectomy (Fig. 8). The most recent postoperative bronchogram showed an extremely marked downward and medial shift of the inferior components of the anterior segmental bronchi to a position perpendicular to the plane of the diaphragm, and the terminal bronchi extended to the level of the diaphragm. The remainder of the upper lobe bronchi showed some fan-

[2] This case is not illustrated.

like spreading, mostly anterolateral and downward.

The major burden of the compensatory bronchial shift on either side (Figs. 7 and 8) falls on the anterior segmental bronchi of the upper lobe, which swing downward, medially, and somewhat posteriorly so that their axes are finally perpendicular to the diaphragm. The extent of shift appears greater on the left.

Resection of Right Middle Lobe and Basal Segments of Right Lower Lobe (2 Cases): In 2 cases in which the right middle lobe and basal segments of the right lower lobe were resected, the shift of the anterior segmental bronchi of the upper lobe was in a downward and medial direction (Fig. 9), similar in character but of lesser degree than that seen following resection of the middle lobe

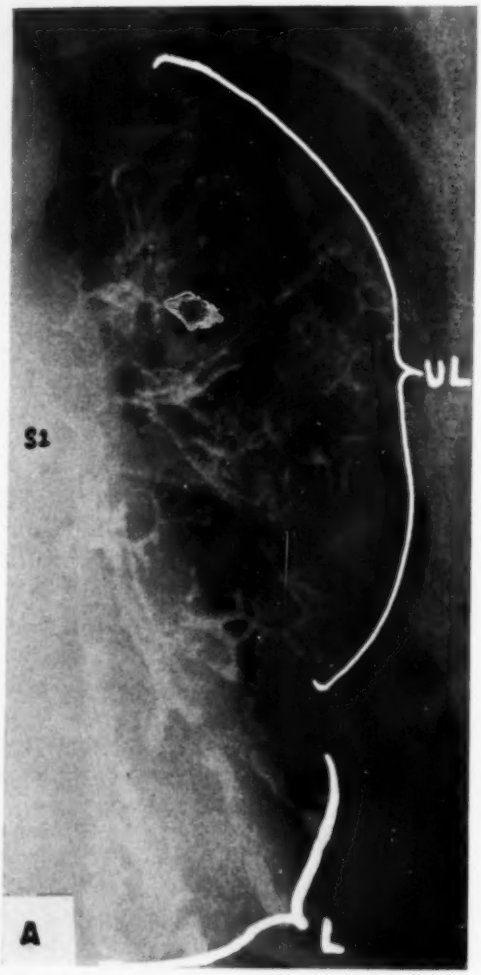

Fig. 8A. Left lower lobectomy. Postero-anterior bronchogram seven months postoperatively. Downward, medial, and posterior displacement of lingular bronchi. UL. Apical-posterior and anterior segmental bronchi of upper lobe. L. Lingular bronchi. S1. Stump of resected lower lobe.

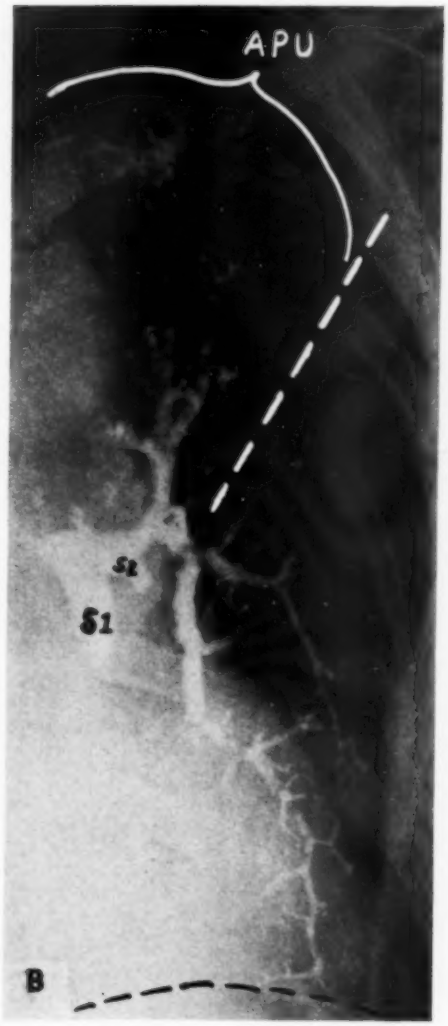

Fig. 8B. Same case as in Fig. 8A following lingulectomy. Postero-anterior bronchogram two years later, showing extremely marked shift of anterior segmental bronchi with terminal branches reaching the diaphragm (interrupted black line). S1. Lower lobe stump. S2. Lingular stump. APU. Apical posterior segmental bronchi of upper lobe.

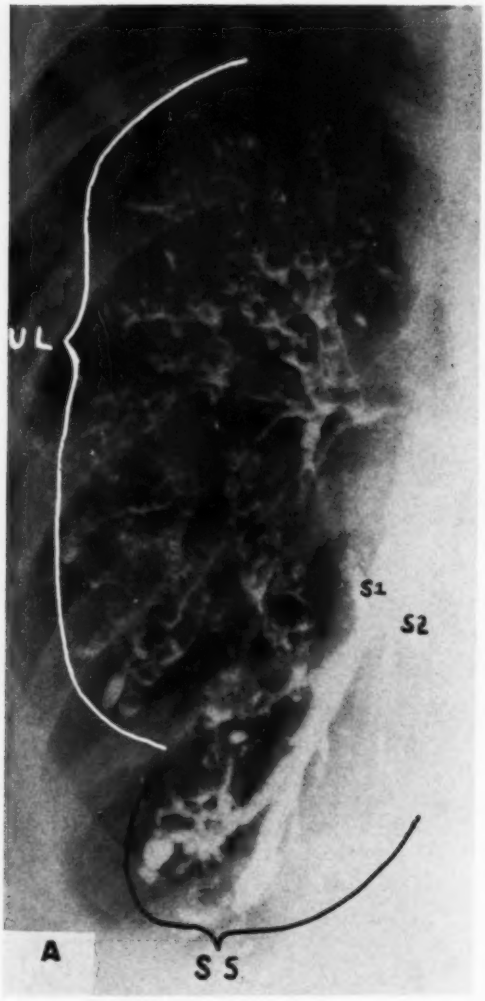

Fig. 9A. Resection of right middle lobe and basal segments of lower lobe. Postero-anterior bronchogram six months postoperatively. Terminal bronchi of superior segment reach the level of the diaphragm. UL. Upper lobe. SS. Superior segment. S1. Middle lobe stump. S2. Lower lobe stump.

and entire lower lobe on the right (Fig. 7). There was an essential difference, however. The superior segment remaining intact, the anterior segmental bronchi of the upper lobe did not shift posteriorly; the superior segmental bronchi spread somewhat in a downward and anterior direction.

Lingulectomy and Resection of Basal Segments of Left Lower Lobe (3 Cases): Only 1 of the 3 cases of lingulectomy and resection of the basal segments of the left lower lobe can be considered representative (Fig. 10). An anatomic variation excludes one of the others; and in the remaining one, postoperative complications interfered with the spatial adjustment. In the one representative case, the bronchogram showed a marked downward and anterior shift of the superior segmental bronchi of the lower lobe, with slight posterior "kneeling" of the terminal bronchi and some lateral shift. In conjunction, there was marked downward, medial, and posterior shift of the inferior component of the anterior segmental bronchi of the upper lobe, without, however, the abrupt angulation which was noted in those cases in which the entire lower lobe and the lingula were resected (Fig. 8).

In the second case, postoperative empyema necessitated rib resection, the resultant marked pleural reaction apparently preventing major bronchial readjustment.

The third case was unusual in that the superior segment of the lower lobe was found at operation to be as large as all of the basal segments combined. The postoperative bronchogram showed downward, lateral, and anterior fanning-out of the bronchi of this superior segment over the entire lower lobe area. Compared with the marked displacement in the "typical" case described, the shift of the anterior segmental bronchi of the upper lobe was not great.

When one compares cases of combined resection of the middle lobe and the basal segments of the lower lobe on the right, with cases of combined lingulectomy and resection of the basal segments of the lower lobe on the left (Figs. 9 and 10), one finds displacement of the upper lobe bronchi slightly more marked on the right than on the left. This finding is in accord with the anatomic studies of Boyden (5), who noted that the superior segment on the right as a rule differs from the left. It caps the basal segments horizontally on the right and obliquely on the left; a large dorsal branch is present in 45 per cent of superior segments on the left side.

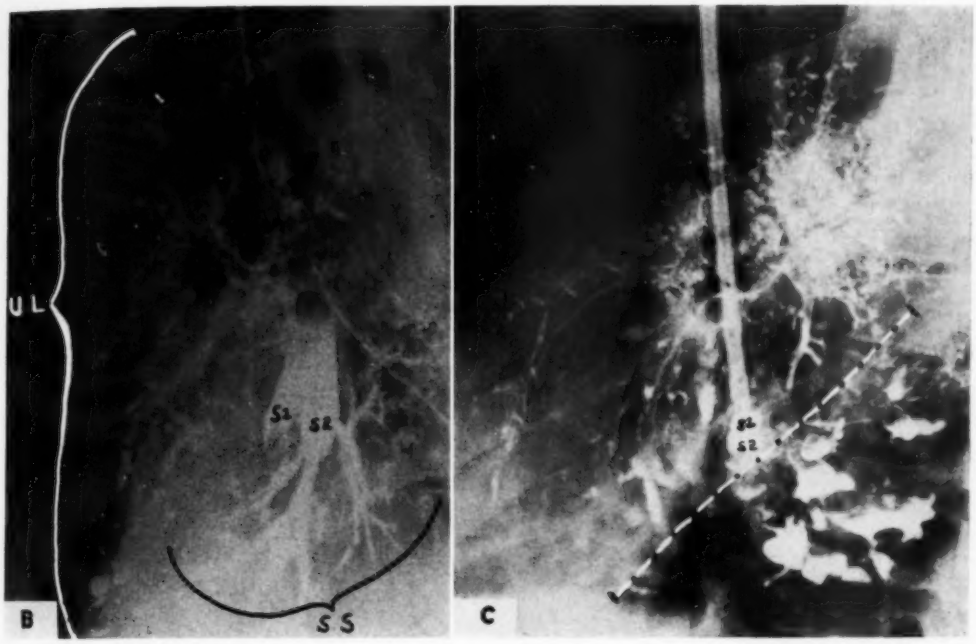

Fig. 9B. Left anterior oblique bronchogram of same case as Fig. 9A, affording better visualization of distribution of superior segmental bronchi.

C. Right lateral bronchogram two years postoperatively in a similar case. Bronchiectasis of superior segmental bronchi emphasizes the spatial rearrangement which has occurred (see text). The interrupted white line delimits the bronchiectatic superior segmental bronchi.

Resection of Basal Segments of Right Lower Lobe (1 Case): In the 1 case in which the basal segments of the right lower lobe were resected, the middle lobe bronchi shifted and spread in a downward and posterior direction, the bronchi of the superior segment of the lower lobe spreading anteriorly and downward (Fig. 11). The anterior bronchial branches of the upper lobe made a slight compensatory movement downward.

As one would expect, the bronchial shift corresponds in general to that observed in total right lower lobectomy but is less extensive.

Resection of Basal Segments of Left Lower Lobe (2 Cases): The positional changes in the 2 cases of resection of the basal segments of the left lower lobe were much the same, the lingular bronchi shifting markedly downward and medially, the peripheral branches assuming a "kneeling" pattern (Fig. 12). There was minor downward shift of the anterior segmental bronchi of the upper lobe and some downward and lateral swing of the superior segmental bronchi of the lower lobe.

In these cases, the lingular bronchi undergo the major spatial rearrangement, the course and extent of the shift being essentially that seen following complete left lower lobectomy (Fig. 6), except that there is no posterior displacement.

Following resection of the basal segments of the lower lobe on the left, the requisite adjustment of the lingular bronchi is more marked than that made by the middle lobe bronchi following a similar resection on the right.

DISCUSSION

Our study shows that, after pulmonary resection, the bronchial tree remaining on the operated side rearranges itself in a typical pattern which varies chiefly with the segment or segments removed.

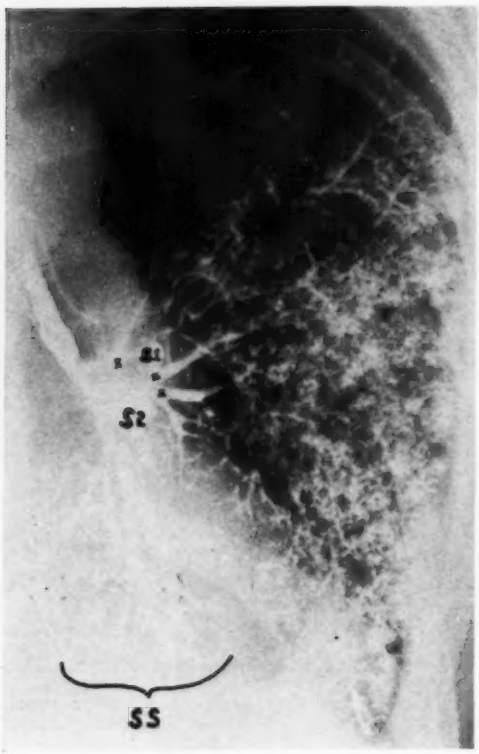

Fig. 10. Lingulectomy and resection of basal segments of left lower lobe. Postero-anterior bronchogram three months postoperatively. Compare position of anterior segmental bronchi of upper lobe with position in Fig. 8B, where superior segment was resected. S1. Lingular stump. S2. Stump of resected basal segments. AP. Apical-posterior segmental bronchi. A. Anterior segmental bronchi. SS and x-x-x. Superior segmental bronchi.

The general direction of bronchial shift is the same as that occurring in atelectasis (15), but the extent of the shift is more marked. In cases where more than one lobe is resected, the degree of shift is astoundingly great. But in the light of Jarre's (17) cineroentgenographic studies which demonstrate the considerable physiological mobility of the bronchi, this fact is not too surprising. Jarre showed that a bronchial-angle change of 41 to 81 degrees occurred during respiration, the bronchi opening and closing with a fan-like motion. Huizinga and Smelt (15) confirmed this finding.

An observation made in the course of our study that will bear further investigation is the phenomenon of "kneeling" of the terminal bronchi noted in a few instances; it has not previously been reported, nor can we at this time offer any definite explanation for it.

Departures from the typical pattern of spatial rearrangement may be explained by postoperative complications or by anatomic variations. In the latter instance the importance of careful preoperative and postoperative bronchographic studies is obvious.

An accurate understanding of what is to be expected in the way of spatial bronchial rearrangement following pulmonary re-

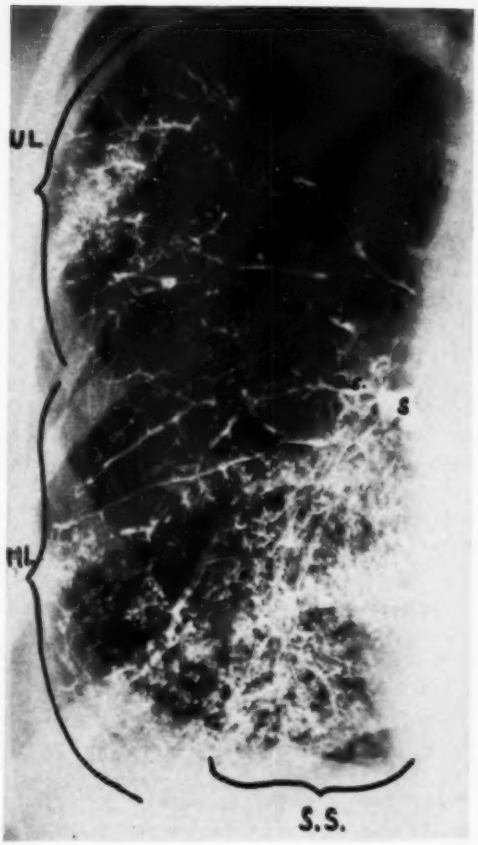

Fig. 11. Resection of basal segments of right lower lobe. Postero-anterior bronchogram two years postoperatively. Compare with Fig. 4A. Preservation of the superior segmental bronchi diminishes the required shift of middle lobe bronchi. UL. Upper lobe bronchi. ML. Middle lobe bronchi. SS. Superior segmental bronchi of lower lobe. S. Stump of resected basal segments.

section is particulary valuable in cases where the postoperative recurrence of symptoms necessitates re-examination.

"CAUSES" OF POSTOPERATIVE BRONCHIECTASIS

In addition to investigating spatial bronchial rearrangement, we attempted to analyze the data gathered from our series of cases with a view to clarifying the problem of postoperative bronchiectasis.

In evaluating the data to be discussed, it should be kept in mind that our group of patients consisted only of those who had re-examinations because of persistent or recurrent symptoms. In the majority of patients with pulmonary resections there were no indications for a repetition of bronchography because they were symptom-free. Therefore, the over-all incidence of postoperative bronchiectasis is far lower than appears from the following discussion.

There were 13 patients in whom bronchiectasis was noted after operation. On review of the preoperative bronchograms, it was found that 9 cases were due to incomplete preoperative study. Bronchiectasis had been present in the preoperative bronchogram in other than the bronchopulmonary segments removed at the subsequent operation. This observation makes it worth while to re-emphasize the importance of complete preoperative bronchography (4, 20, 21, 24, 26, 31). In 4 instances, bronchiectasis developed postoperatively.

The most impressive finding, however, is that bronchiectasis developed or progressed postoperatively in more than half of the cases with postoperative complications. Postoperative complications were present in 6 of the 10 instances in which there was development of bronchiectasis or rapid progression of a pre-existing bronchiectasis. On the other hand, complications were present in only 4 of 21 instances in which *no* change occurred in the postoperative bronchogram. The development of bronchiectasis in segments not previously involved and the rapid progression of pre-existing bronchiectasis in the cases with postoperative complications cannot, in our opinion, be attributed to the natural progression of the disease (25, 27), and the causative relationship of postoperative complications and postoperative bronchiectasis cannot be doubted.

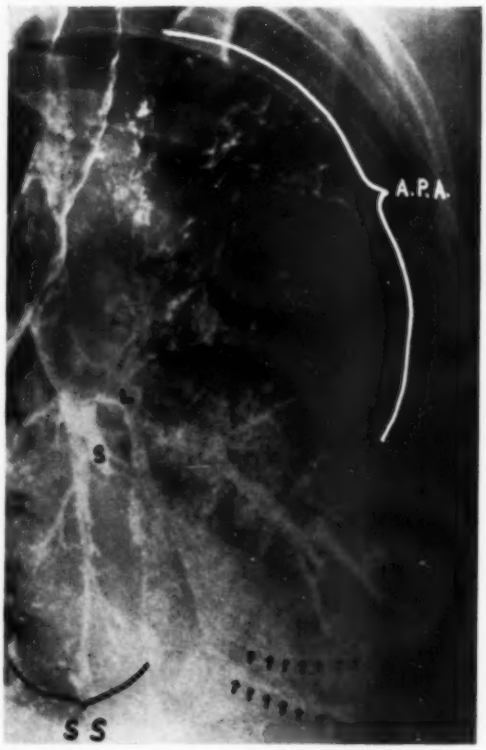

Fig. 12. Resection of basal segments of left lower lobe. Right anterior oblique bronchogram one year postoperatively. Bronchial rearrangement is essentially similar to that following complete left lower lobectomy (Fig. 6B). S. Stump of resected basal segments of lower lobe. L. Lingular bronchus. SS Superior segmental bronchi. APA. Apical-posterior and anterior segmental bronchi of upper lobe.

Atelectasis and pleural disease are two of the most significant postoperative complications (12, 23, 28, 32). These two conditions are known to be responsible for the development of *primary* bronchiectasis. It is therefore not surprising that, when they occur postoperatively, they are capable of producing *postoperative* bronchiectasis (Figs. 13 A and B).

In collapsed lungs the dilating force of the physiological respiratory movements is

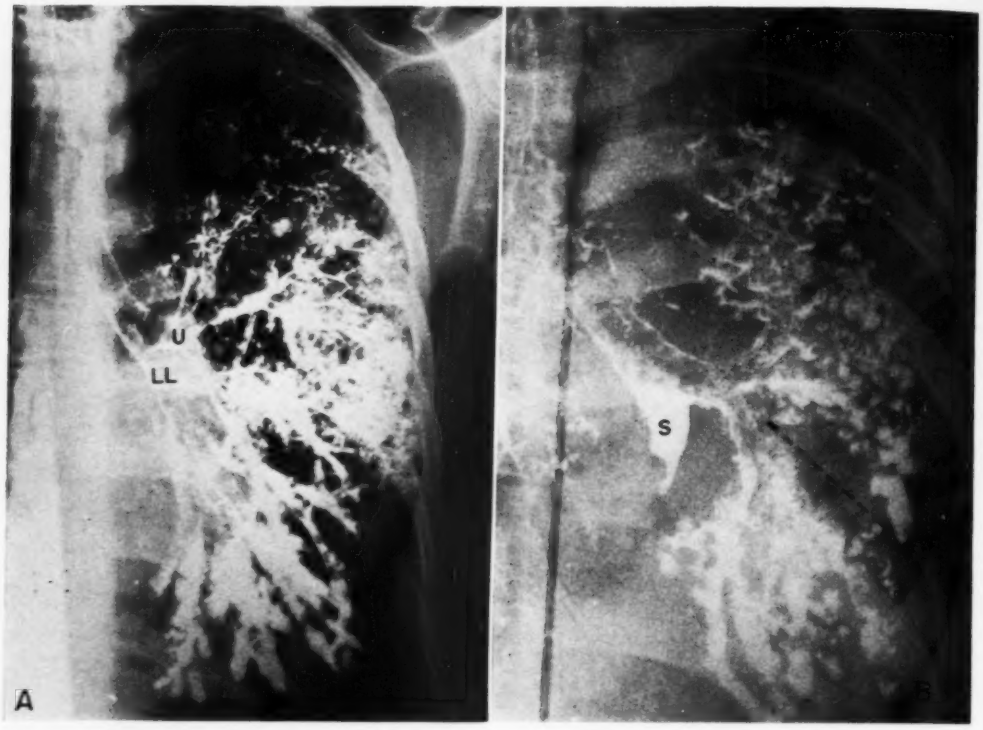

Fig. 13. A. Preoperative postero-anterior bronchogram showing bronchiectasis of the left lower lobe and incomplete filling of lingula. U. Upper lobe. LL. Lower lobe.
B. Postero-anterior view of same patient six months after left lower lobectomy. Complete atelectasis of entire left upper lobe with bronchiectasis of all bronchial branches due to postoperative complications. S. Stump of lower lobe. The interrupted line separates the bronchiectatic lingular branches from the remaining bronchiectatic branches of the upper lobe.

no longer cushioned by elastic parenchyma, thus leading to bronchial dilatation and subsequent bronchiectasis (2, 9, 10). Postoperative pleurisy may have a similar effect. This, however, is not the inexorable course followed in every case, since under treatment, or sometimes spontaneously, all or most of the atelectasis may regress before permanent bronchial-wall changes have resulted (reversible bronchiectasis) (11). This may explain 4 cases in the present series in which postoperative complications were present without evidence of postoperative progression or development of bronchiectasis.

The importance of avoiding postoperative complications cannot be sufficiently emphasized (19). The prevention or prompt treatment of postoperative collapse or other complications seems to offer the best chance of avoiding postoperative bronchiectasis (21).

It has been suggested in the literature that one of the factors possibly implicated in the development of bronchiectasis after pulmonary resection is overdistention of the remainder of the lung, with kinking of the bronchi secondary to their displacement (14, 31, 33). But uncomplicated pulmonary resection is not followed in most instances by kinking of bronchi despite a marked bronchial shift associated with parenchymal overdistention. Nor is pulmonary function significantly impaired by uncomplicated pulmonary resections, provided these are not too extensive (3, 13). It is mainly in the presence of postoperative complications that major anatomic and functional disturbances occur (18, 22, 29, 32).

If bronchial rearrangement after operation were frequently responsible for postoperative bronchiectasis, one would expect to find the largest incidence of postoperative bronchiectasis where the greatest number of segments had been removed, since it is in these cases that the most pronounced bronchial shift occurs. In our material this did not prove to be the case. The 5 patients in whom two lobes were removed on the right side and the 1 patient whose lower lobe and lingula were removed on the left did not have postoperative bronchiectasis. It would therefore appear that postoperative spatial rearrangement of bronchi *per se* cannot frequently be a significant factor in the etiology of postoperative bronchiectasis.

There were 2 cases in our series, however, in which bronchiectasis developed and 2 others in which bronchiectasis progressed in the absence of gross postoperative complications. The possibility that spatial readjustment may be contributing in some instances to the development of bronchiectasis can therefore not be denied in *all* cases. It will thus be necessary to examine a much larger series than ours repeatedly over a period of time before a definite opinion can be formed on this question. At the present time it seems more important to stress the need for choosing a resection technic that will minimize postoperative complications rather than one that will diminish bronchial shift.

CONCLUSIONS

A comparative study of preoperative and postoperative bronchograms of patients with pulmonary resections was carried out in an attempt to determine whether or not a predictable pattern of postoperative bronchial rearrangement exists.

It was found that typical patterns prevail and that these are determined by the location and size of the pulmonary segments removed. These typical patterns following various resections are illustrated.

Spatial bronchial rearrangement is modified by the presence of anatomic variations and the occurrence of postoperative complications.

Postoperative bronchiectasis may be traced in many instances to bronchiectasis that exists preoperatively but is not recognized because of incomplete studies. In cases in which bronchiectasis actually develops postoperatively, it is due mainly to postoperative complications.

It appears that spatial adjustment resulting in spreading and changing of "take-off" angle of the remaining bronchi does not play a frequent role in producing bronchiectasis. Further studies of the incidence of postoperative bronchiectasis without postoperative complications are indicated.

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SUMARIO

La Redisposición de los Bronquios y la Bronquiectasia Consecutivamente a la Resección Pulmonar

Tratando de determinar si existe o no un patrón predecible de redisposición bronquial postoperatoria, se llevó a cabo un estudio comparado de los broncogramas pre- y postoperatorios de enfermos en quienes se hicieron resecciones pulmonares. Obsérvose que rigen patrones típicos y que son determinados por la localización y el tamaño de los segmentos pulmonares extirpados. Esos patrones típicos consecutivos a varias resecciones aparecen aquí ilustrados.

La nueva disposición del espacio bronquial es modificada por la presencia de variaciones anatómicas y la ocurrencia de complicaciones postoperatorias.

La bronquiectasia postoperatoria puede ser conectada en muchos casos con una bronquiectasia que existía antes de operar pero que no había sido reconocida por ser incompletos los estudios realizados. En los casos en que se presenta bronquiectasia realmente postoperatoria, se debe principalmente a complicaciones postoperatorias.

Parece que el ajuste del espacio, que acarrea dilatación y variación del ángulo de "partida" de los bronquios restantes no desempeña papel frecuente en la producción de bronquiectasia. Están indicados estudios ulteriores de la incidencia de la bronquiectasia postoperatoria sin complicaciones postoperatorias.

Significance of Unilateral Enlargement of the Hilus Shadow in the Early Diagnosis of Carcinoma of the Lung

With Observations on a Method of Mensuration[1]

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IT IS GENERALLY agreed that any decrease in deaths from bronchogenic carcinoma must come by way of early diagnosis and early treatment. Since this disease is usually found to be incurable at operation, the need for more prompt diagnosis is apparent (2). By the time the characteristic signs are discernible in the roentgenogram, the tumors are usually well advanced.

In the past few years, routine chest roentgenograms and mass-survey chest examinations have been done on a great number of persons as public health, industrial, or hospital admission procedures. It seems logical, then, to look to this widely accepted and practical method for early diagnosis where no symptoms are present. However, disappointingly few bronchogenic carcinomas have been discovered in this manner. Can it be possible that we are reaching the point of diminishing returns in so far as the roentgen criteria of minimal lung cancer are concerned?

For a number of years one of us (L.G.R.) has investigated the past roentgenologic history of individuals with known carcinoma of a bronchus. One of the observations, previously reported (8, 9, 10), has been that a unilateral enlargement of the hilus is a frequent and important early, presymptomatic sign of bronchogenic carcinoma. The reasons why a bronchogenic carcinoma should produce only an enlargement of the hilus shadow must be considered. The tumor, under such circumstances, is usually located in one of the larger bronchi but has not yet occluded the lumen sufficiently to produce any obstructive phenomena. Furthermore, it has not yet ulcerated sufficiently to cause cough, hemoptysis, or other symptoms of carcinoma. But it may well have extended through the bronchial wall to produce a peribronchial infiltration or an actual tumor mass. In some instances extension to the regional lymph nodes has already occurred and the shadow is largely due to the enlarged nodes. Despite such extensions, there may be no involvement of other portions of the lung or mediastinum.

In order to test the frequency of this finding, a systematic review was undertaken of the early roentgenograms of 50 cases of carcinoma of the lung, all fortuitously made before the development of symptoms (6). The group showed no single pattern of the minimal subcritical lesion but rather a fairly random scattering of signs. One interesting fact did emerge, however. In half of the lesions observed at this early stage, before the onset of symptoms, the first roentgen evidence was a unilateral enlargement of the hilus shadow; it was this sign which was most frequently overlooked. Conversely, non-specific peripheral lesions, well outlined in the air-filled lung, were readily discovered. These latter lesions, called by a variety of names (tuberculomas, pulmonary nodules, coin lesions, etc.) have been studied intensively in recent years. They are generally assumed to be malignant tumors until proved otherwise. They can be diagnosed and treated best by prompt removal.

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[1] From the Department of Radiology of the University of Minnesota Medical School and the Veterans Administration Hospital, Minneapolis, Minn. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

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Abnormalities of the hilus are not disposed of so easily. Here the problem, directly solved by excision biopsy in the case of peripheral lesions, is rendered difficult by the general inability to recognize minor degrees of abnormality. The problem is not so much one of diagnosis as one of detection. Small pathological variations in the pleomorphic hilar shadows blend with the expected normal variations. Such minimal carcinomas were overlooked in 23 of the early asymptomatic cases studied.

A density in the region of the root shadow of the lung, as seen in a simple postero-anterior roentgenogram, may be deceptive, since lesions in the medial superior portion of the lower lobe may be superimposed upon the hilus shadow and be indistinguishable from actual change within the hilus itself. Thus the roentgen diagnoses of central pneumonia were found to be largely in error when lateral views were made, the consolidation usually proving to be peripheral and medial but not central. For this reason, it is obviously necessary to obtain lateral or oblique roentgenograms when an enlargement of the hilar shadow on one side is suspected, in order to determine definitely that the abnormality is actually in the hilus. The difficulty, however, lies in the failure to recognize minor degrees of change in the size or density of the shadow as being significant. The frequency with which such changes are encountered—changes which are probably the result of previous inflammatory disease—tends to dull the sensitivity of the radiologist to their importance. Yet in our experience this sign is by far the most commonly overlooked early evidence of carcinoma of the lung. That unilateral enlargement of the hilus is not necessarily diagnostic of carcinoma goes almost without saying. The importance of the observation lies in the detection of an abnormality. Multiple roentgenograms, body-section roentgenography, bronchography, bronchoscopy, and microscopic study of the sputum may be necessary for the establishment of a definitive diagnosis. But such procedures will not be undertaken unless there is observed an abnormality which indicates the possibility that carcinoma is present.

Since this difficulty of early recognition of hilar enlargement often irretrievably delays diagnosis and treatment, it occurred to us that a mechanical aid such as is used in cardiac mensuration would be helpful. With this possibility in view, we set about measuring the size of the hilus of the lung. Proved cases of carcinoma which appeared to begin in the hilus were compared with observations on a control group of normal persons of the same age. Two approaches were used. The first, an effort to measure the vertical diameter of the hilus, met with little success and was abandoned when it became apparent that it would not be productive. The second approach utilized a measurement of the transverse diameter of the hilus.

METHOD

In order to measure the transverse diameter of one hilus, its medial and lateral margins must be determined. Its encroachment upon the aerated lung field laterally usually is moderately well defined. The medial margin, however, is commonly indistinguishable on conventional roentgenograms. A transverse diameter measurement may be effected by arbitrarily fixing as the medial border of the hilus a vertical mid-thoracic line bisecting the horizontal transthoracic diameters at the aortic arch and at the diaphragm. The distance between the lateral margin of the visualized hilus and the vertical mid-thoracic line we have designated the transverse diameter of the hilus (Fig. 1). The line traversing this diameter should be perpendicular to the mid-thoracic line. Since the left hilus is usually higher than the right, the right and the left diameters are rarely continuous.

It is obvious that the placement of the mid-thoracic line is of great importance, since a shift to either side would double the difference between the transverse diameters of the two hili. In the consideration of the total transverse diameter

of both hili the mid-thoracic line would be of little importance. Distortions of the bony cage, or films made with some obliquity or actual errors in placement, might minimize the value of comparative right and left measurements. It is significant, however, that in the series of normal controls studied in this way, the differences in size of the two hili were found to be relatively small.

Another source of error could be the determination of the lateral border of the hili. To determine this point, we chose that margin of the hilus farthest from the midline but not including the first branchings of each pulmonary artery. The point selected as the lateral margin is subject to varying interpretation. The measurements are therefore not completely objective.

The diameters of the right and of left hili were determined in the above manner upon a group of 100 patients selected for control studies. These measurements were tabulated for each individual and then for the whole group. Similar measurements on 127 patients with proved carcinoma of the lung involving the hilus were recorded in the same manner. The measurements of the transverse diameter of one hilus of the control group fell between 3.5 and 7.0 cm., while those in the carcinomatous group ranged up to 11.5 cm. In order to facilitate comparisons between these groups, they were lumped together and the range of transverse diameters of 3.5 to 11.5 cm. was divided into 12 arbitrarily selected equal groups of 0.58 cm. The frequency of these measurements (per cent) was then plotted against this range.

The sum of the transverse diameters of both hili of each individual in the control group was also recorded and compared to the sum of the right and left transverse diameters of the carcinomatous group. This comparison is presented graphically in Figure 2. The difference between the right and left hilus of the control series and between the right and left hilus of the carcinomatous series (*i.e.*, the involved *vs.* the supposedly uninvolved hilus) is shown graphically in Figure 3.

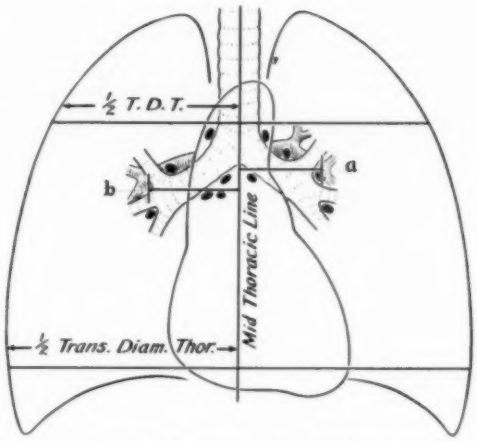

Fig. 1. Method of mensuration of the hilus shadows. Transthoracic diameters of the thorax are drawn at the levels of the aortic arch and the diaphragm, measured from the inner margins of the thoracic cage. A vertical mid-thoracic line is found by bisecting these two diameters. Transverse lines extending from the mid-thoracic line to the most lateral margin of the hilus shadow on each side (*a* and *b*) are drawn, representing an arbitrary transverse diameter of the hilus.

The transverse diameters of the carcinomatous hili were similarly computed, tabulated, and plotted against the transverse diameters of the right hilus for the control series and are shown in Figure 4. The statistical significance of the difference between appropriate groups was determined. Mean and standard deviations and critical ratios are indicated on the accompanying graphs.

OBSERVATIONS

The transverse diameter of each hilus was determined in all of the 100 controls. It varied from 3.5 to 7.0 cm., with the greatest number at 5.5 cm. The curves representing these measurements were quite sharp and showed no significant difference in the distribution of measurements between the right and the left hilus. The sum of the measurements of the right and left hilus in each control showed a similar curve, with its apex at 11 cm. Individual variations within the control series are demonstrated by the steep curve representing the differences

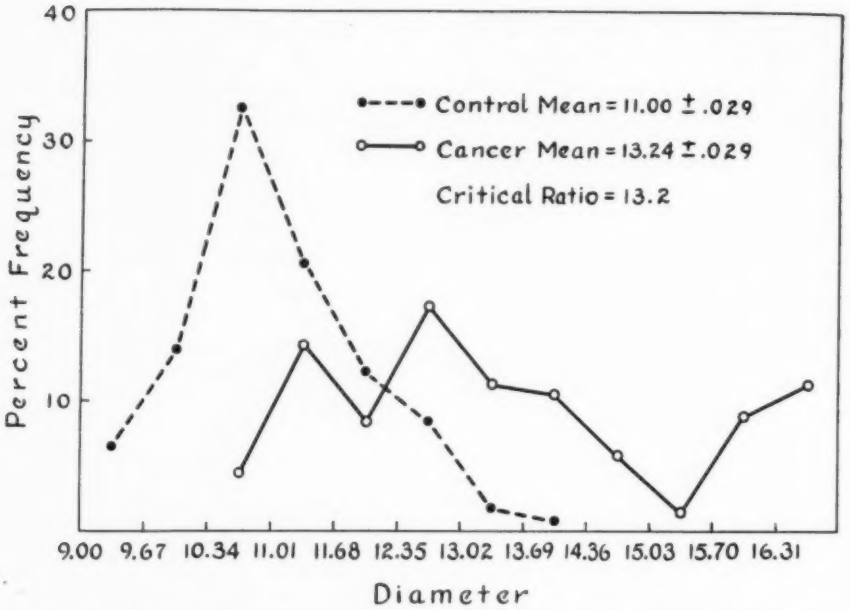

Fig. 2. The sum of transverse diameters of the right and left hili was determined in 100 non-carcinomatous control and 127 patients with known bronchogenic carcinoma affecting one hilus. The data are plotted here as curves, the broken line representing the control series, the solid line the tumor cases. It will be noted that there is some overlap between the normals and the tumor-bearing patients in the range of diameters from about 10.5 to 13.7 cm., but a total diameter exceeding 13.0 cm. occurred in less than 10 per cent of the normals, while if the diameter were less than 11.0 cm. there appeared to be little chance of a carcinoma being present. Forty-two per cent of the patients suffering from carcinoma, however, had total transverse measurements which were under 13 cm.

between the right and left hilus of the same patient. In 84 per cent of the cases, this difference was 1 cm. or less.

Graphic comparison of the carcinomatous hilus with either right or left control (Fig. 4) shows a fairly sharp demarcation between the two series. None of the carcinomatous hili measured as little as 5.7 cm., while in 69 per cent of the controls the transverse diameter was below that figure. An additional 11 per cent of the controls fell between 5.7 and 7.6 cm., in which range occurred 42 per cent of the smaller carcinomatous hili. Actually in none of the normal group was a measurement of over 7.0 cm. obtained. Eighty-four per cent of the control hili were under 6.5 cm. while, coincidentally, 84 per cent of the carcinoma series were above this level. The peak of the curve for the carcinomatous hili lies at less than 7.0 cm., indicating a less than 10 per cent chance

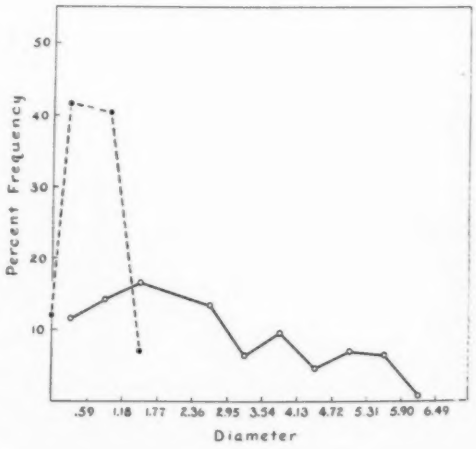

Fig. 3. The difference between the transverse diameters of the two hili of each individual is here plotted. Again, the controls are shown as a broken line, the carcinoma cases as a solid line. The difference in the case of the controls varied from 0 almost to 2.0 cm., but in only one case was it above 1.7 cm. In the carcinoma cases, on the other hand, over 40 per cent have a difference less than 1.7 cm.

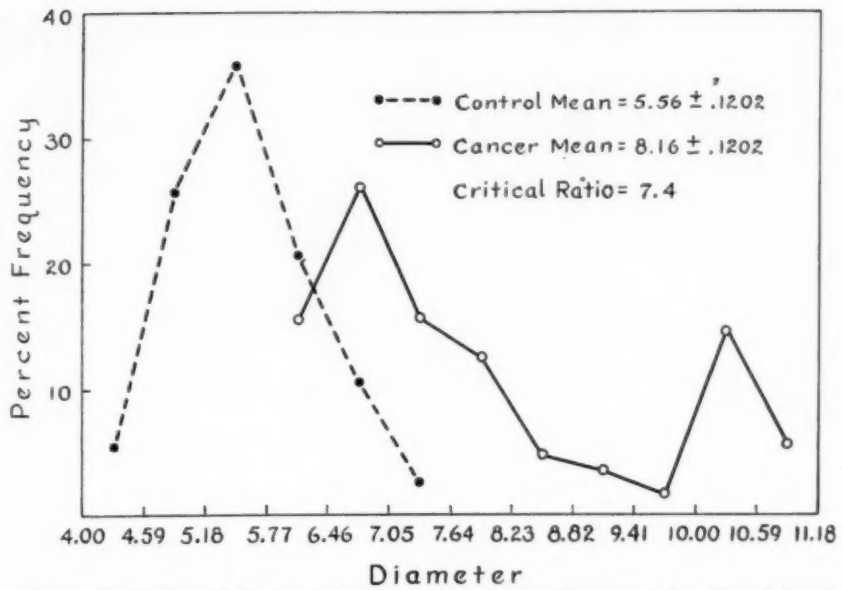

Fig. 4. Comparison of the measurement of the transverse diameter of the affected hilus in known cases of carcinoma with the transverse diameter of the right hilus of the control series is shown. The normal hili are indicated by the broken line, the carcinomatous hili by the solid line. The difference is sharper but, again, there is some overlapping. There were no normals over 7.2 cm. in diameter, but 11 per cent of the normals fell in the range between 5.7 and 7.0 cm. In this same range were 42 per cent of the carcinomatous hili. However, no carcinomatous hilus measured less than 5.8 cm. Thus, a measurement of 5.7 cm. or less is clearly indicative of a normal and above 7.0 cm. of an abnormal hilus.

of such a hilus being a normal variation.

The sum of the right and left hilar diameters confirms the observations on the diseased hili alone, despite the impediment of a presumably normal hilus on the opposite side. Here the range was found to be between 11.0 cm. (average of controls) and 17.0 cm., with the greatest concentration of cases at 13.0 cm. (Fig. 2). Control studies similarly conducted show that a hilus of 13.0 cm. has only a 10 per cent chance of not being diseased. Nevertheless, in one of the patients having bronchogenic carcinoma the sum of the diameters of the hili was less than 11.0 cm., the average for the control group.

The difference between the right and left hilar diameters in the control series offers the shortest range of values and the most precipitous curve of any of the control studies. Comparison with carcinomatous cases so studied again shows a wide range and low gradient in the latter group (Fig. 3). Although any difference over 1.7 cm. has only a 10 per cent chance of being a normal variation, still 42 per cent of cancer patients have less than this difference. Because the use of the opposite hilus for comparison obviates consideration of many incalculable factors, and because of the convenience of such a control, this may be an important index of unilateral hilar enlargement. The attempted removal of the damping effect of the supposedly normal hilus by this maneuver could be vitiated by mediastinal metastases to the opposite side. Furthermore, the possibility of error in the placement of the mid-thoracic line, as described above, must be taken into consideration.

DISCUSSION

The factors which could distort these studies are as numerous as those affecting any biological material, with added human and pathological complications. Neither these nor the mathematical methods used need be discussed, but the selection of

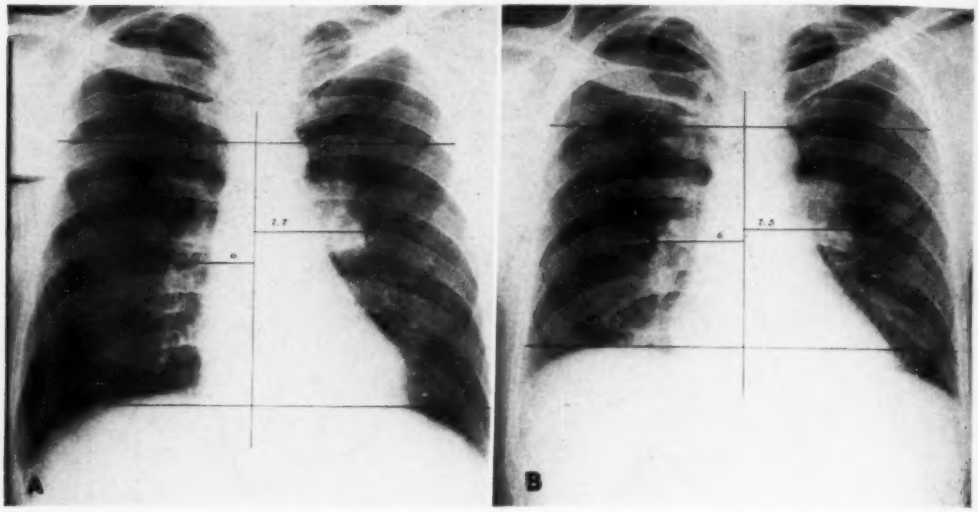

Fig. 5. The method of measurement in an actual case with carcinoma of the left lung is here demonstrated. Note the difference of 1.7 cm. between right and left and the obvious increased density as well as increased size of the left hilus. The fact that respiratory phase has little influence on such measurements when obstructive emphysema is not present is also illustrated.
A. Full inspiration. B. Full expiration.
Note the slight change in measurements which has occurred in these two phases of respiration.

controls and the roentgenologic, anatomical, and clinical factors concerned merit mention.

The control group was collected from a consecutive series of 100 routine hospital admission chest roentgenograms of patients over the age of forty. Aside from the rejection of 5 females and 3 cases with such gross cardiac enlargement that the hilus could not be sharply defined, this is a random sample. The control series closely parallels the group of patients with bronchogenic carcinoma. All factors affecting the latter group, other than the presence of carcinoma, should similarly affect the control group. These controls are not entirely free from disease, but the use of such controls compensates for some of the factors subsequently discussed and prevents the acquisition of unduly sharp contrasts in comparison with the carcinomatous patients. Actually the presence of carcinoma is the only difference recognized in the two series. The carcinoma series was composed of 127 patients in whom bronchogenic carcinoma involving the hilus of the lung had been proved.

Roentgen technics were similar in the two groups. The same machines and technicians were used. Minor degrees of rotation were present to the same extent, and in no instance did this offer difficulty in measurement or appear to affect the result in any way. The variations in phase of respiration normally encountered on chest films were compensated by similar variations in the controls. Despite this compensation, a series of 10 controls was studied in deep inspiration and in deep expiration and no significant differences were found in the sums of the diameters of the right and left hili (Fig. 5). Localized emphysema or the emphysema of partial bronchial occlusion causes respiratory shifting of the mediastinum with a consequent great alteration in the difference between the diameters of the hili (Fig. 6). Such localized emphysema is usually obvious and since of itself it suggests cancer of the lung, it presents no obstacle to the diagnosis, although it may impede this method. Postero-anterior chest films exposed at six-foot focus-film distance were used, since in many instances

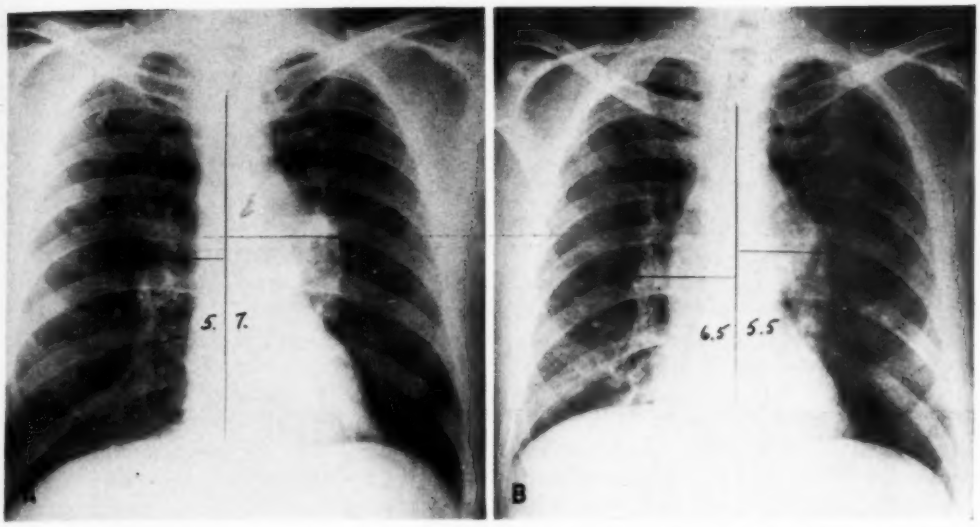

Fig. 6. The effect of respiratory phase in the presence of obstructive emphysema is here shown in a patient with carcinoma of the left lung in which there are both hilar enlargement and expiratory emphysema on the left side.

A. Full inspiration. The left hilus is 2 cm. wider than the right. There is slight evidence of emphysema on the left.

B. Full expiration. Note the obvious obstructive emphysema of the left lung. A shift of the mediastinum to the right has occurred, distorting and changing the transverse hilar measurements. The left hilus now appears to measure less than the right. However, it should be observed that the sum of the diameters remains the same and is well above the normal mean.

these standard projections were the only ones available for study of the early stages of development of carcinoma, and since this is the projection widely used for chest-survey and survey follow-up examinations. Extrapolation of the observed hilar diameters to the shorter distances and diminutive shadows found on 4 × 5-inch, 70-mm., and 35-mm. film has not yet been attempted.

End-points for mensuration were so indistinct in three frank carcinomas with marked atelectasis that these cases could not be used. Difficulties in determining good end-points for the longitudinal diameter of the hilar measurements plus poor curves and lack of contrast prevented use of this approach.

In an attempt to control the expected human and subjective variability, an independent disinterested team repeated the measurements initially recorded. The results corresponded quite closely. Because errors in localizing the mid-thoracic line and the lateral margins of the hilus would be most prominently displayed in the determination of the difference between the hili of the individuals in the control and in the cancer groups, a graph (Fig. 7) was constructed to demonstrate the results of this second study. It is evident that the degree of difference in the results of the two independent measurements would not be statistically important.

Among the anatomical factors of importance, the habitus of the patient must be significant. We know that it is largely for this reason that cardiac mensuration is limited in its usefulness. But because we are not prepared to cope with the difficulties presented by somatotyping, and because we have no mathematical factor with which to account for variations in body type, we must disregard this complication. It may be that many of our wide normal ranges of hilar diameters would be narrowed by inclusion of such a factor or by subgrouping the subjects according to habitus. The use of the contralateral hilus as an individual control compensates

for this factor and, excepting the possible complication of mediastinal metastases, this appears to be practical. The distribution and relationships of the vessels, bronchi, and lymphatics are generally predictable, but roentgen evidence of variation is so common as to be expected. metastases could affect some of the determinations. Clinical factors such as concurrent pneumonia, atelectasis, abscess, phrenic paralysis, pleural effusion either associated with the disease or coincidental to it, could be of importance. They did not enter into the present study because

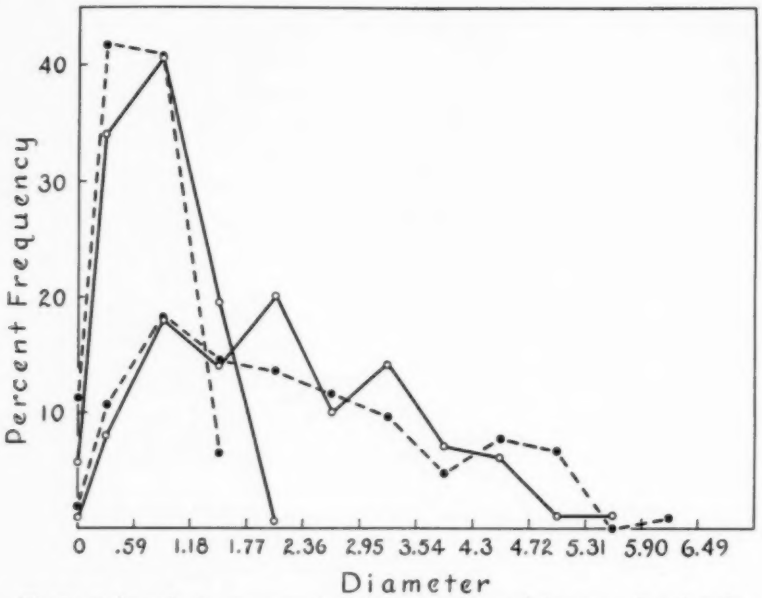

Fig. 7. Independent measurements made by two teams of observers, plotted against each other. The broken lines represent one set of measurements; the solid another. The lines to the left are the measurements of the differences in the diameters of the hili in each individual of the control series; those to the right, of the carcinoma series. It can be seen that the range of difference between the two groups of observers was small, indicating that the factor of individual judgment, while ever present, does not constitute a serious cause of error.

No efforts were made to determine the presence of anomalies or "normal variations." These too could be expected in equivalent numbers in the control group. Cardiovascular aging certainly affects the hilus. This factor too is well spread throughout control and diseased groups. It is of least significance in the tabulation of the diameter of the hilus primarily affected by tumor and in that concerned with the difference between right and left hilar diameters. Pulmonary fibrosis and lymph node enlargement, residual from previous inflammatory processes, also have a random distribution through the control and the subject groups. Contralateral we were concerned essentially with carcinoma in an early stage.

A statistically significant difference between the control series and the carcinomatous series was found in each measurement. The mean and standard deviation and the critical ratio are noted with the appropriate graphs. The measurable difference seems to be less striking than one would expect considering the prominence of the tumor shadow in many of the more advanced examples. Even in those of minimal extent, the lesions appear larger to the eye than would be expected from the measurements recorded. We have often seen an obliteration of the inner

aspect of the pulmonary artery shadow which gives an appearance of solidity to the hilus without enlarging its measurable diameters. This is a change that is difficult to approach mechanically. It may be that the practised eye estimates as volumetric changes those variations in the diameter of the hilus which are here measured as linear changes. In this way the minor changes detected would be greatly magnified. The roentgenologic and clinical judgment of a trained observer is usually more sensitive than the tests presented, since the many complicating factors are automatically fed into his mental computations as his experience dictates. Here, as in cardiac mensuration, the mental forms are more flexible than the mathematical norms.

The diameter of the normal hilus as measured by this method is 5.5 cm. There is no difference in this mean diameter between the right and left hilus, and the mean sum is 11.0 cm. There may, however, be a discrepancy in individual cases of 1.0 cm. between normal hili of a normal patient. In at least 84 per cent of normal cases the difference between the right and the left hilus did not exceed 1.0 cm.

The sum of the diameters of the hili of the carcinomatous patients have a wide range, with a mean of 13.0 cm. One of these cases fell within the mean of the sum of the diameters of the normal hili (11.0 cm.).

It would appear that measurements should indicate the presence or absence of an abnormality in at least 90 per cent of cases. If either hilus is found to be over 7.0 cm. in diameter, the figure alone indicates abnormality, since 90 per cent of normal hili measured less than 7.0 cm. and none exceeded this figure. If the sum of the diameters of the hili is under 11.0 cm. according to this method, there is little chance of carcinoma being present; but if this sum exceeds 13.0 cm., there is less than a 10 per cent chance that the subject is normal. In none of the control series did the combined measurements exceed 13.0 cm., and in only one patient in the carcinoma series was the sum less than 11.0 cm. A 42 per cent chance of there being a negative error remains, since this percentage of carcinomatous patients have hili whose measurements lie within the upper limits of the normal range.

If the difference between the right and the left hilus is greater than 1.7 cm., there remains only a 10 per cent chance of the larger of the two being normal. In only one of the control series of 100 was there a difference of 2.0 cm. between the right and left hilus.

Using combinations of these rules, one could find this method helpful in enough instances to justify its use. Since measurement of the diameter of the hilus requires no special equipment and only a few extra minutes time, and since the need for earlier detection of hilar lesions is so obvious, the procedure deserves a trial. Certainly, in cases where simple observations leaves the radiologist in doubt, the use of such a tool is not only advisable but it may be the only remaining route to an early definitive diagnosis.

SUMMARY

1. Unilateral enlargement of the hilar shadow of the lung is the most commonly overlooked early sign of bronchogenic carcinoma.

2. The necessity for improved discernment of neoplastic hilar enlargement is presented.

3. A method for mensuration of the roentgen shadow of the hilus is proposed.

4. The method was applied to 100 routine chest roentgenograms as a control series, and "normal" ranges, with mean and standard variations, of the "diameter of the hilus" are presented.

5. The measurement was applied to 127 hilus shadows in the presence of histologically verified bronchogenic carcinoma.

6. Statistically significant differences between the control and carcinomatous groups were found.

7. Significant measurements are presented which indicate unilateral hilar

enlargement. Such measurements may be utilized as an early sign of primary bronchogenic carcinoma.

8. Critical judgment of experienced roentgenologists cannot be supplanted by these determinations, but assistance in forming the criteria for such judgment may be provided.

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SUMARIO

La Importancia del Aumento Unilateral de la Imagen del Hilio en el Diagnóstico Temprano del Carcinoma Pulmonar, con Observaciones Relativas a un Método de Medición

La dilatación unilateral de la sombra del hilio pulmonar es el signo temprano del carcinoma broncógeno que se pasa por alto más habitualmente. Como el diagnóstico y el tratamiento de la enfermedad se ven a menudo irremediablemente demorados por lo difícil que es reconocer tempranamente dicha dilatación hiliar, se ideó un método para la medición radiográfica del diámetro transversal del hilio, y luego se compararon los resultados obtenidos en 127 casos comprobados de carcinoma del pulmón y en un grupo de 100 testigos normales. La medición se hace fijando como borde medio del hilio una línea mesotorácica vertical que bisecta los diámetros transtorácicos horizontales en el cayado de la aorta y en el diafragma. La distancia que media entre la porción más ancha del hilio visualizado y dicha línea mesotorácica representa el diámetro transversal del hilio.

Observáronse diferencias estadísticamente significativas entre el grupo testigo y el carcinomatoso. Preséntanse mediciones significativas que indican dilatación unilateral del hilio y que pueden utilizarse como signo temprano del carcinoma broncógeno primario.

No pueden suplantar tales determinaciones el juicio analítico del radiólogo avezado, pero sí pueden ser de ayuda al trazar pautas para dicho juicio.

DISCUSSION

(Papers by Wyman and Eyler; Ettinger, Bernstein, and Woods; Rigler, O'Loughlin, and Tucker)

Laurence L. Robbins, M.D. (Boston, Mass.): It gives me a great deal of pleasure to have the opportunity to discuss these papers.

So far as the presentation by Dr. Wyman and Dr. Eyler is concerned, it seems to me that this represents simply one step further in the delineation of some of the cystic lesions of the lung. There is one point which has been brought up about cysts in the lower lobe which are infected that makes one skeptical about the diagnosis of so-called sequestration. In many cases of bronchiectasis of the lung there may develop rather huge bronchial arteries which may appear somewhat anomalous and could readily be confused with sequestration. The most important fact brought out is that we have the opportunity of warning the surgeon that there may be an abnormal arterial supply, and perhaps in this way helping to save a patient's life.

Dr. Ettinger's presentation on the rearrange-

ment of the bronchial tree is the best that I have seen. I have envied her the opportunity of studying these cases. We tried to do it a few years ago but did not have sufficient postoperative material available. To those who have made the statement that the thoracic surgeon merely increases the amount of bronchiectasis, she has given a proper answer, and I think has done it conclusively.

One reason why she found as many cases of bronchiectasis as she did is the fact that in many instances the operation was performed in the days of the tourniquet approach to the bronchus and before dissection was carried out with adequate and complete closure, as is done at present. This, I think, was one of the factors that tended to increase complications. Today, the use of antibiotics should decrease the number of complications in this group.

One thing that is important, whether surgery be abdominal or thoracic, is that the possibility of postoperative collapse still exists, and it behooves us to point this out to the thoracic surgeon so that the development of bronchiectasis or further complications may be obviated.

I have talked with Dr. O'Loughlin about the paper on hilar measurements and I am very enthusiastic about finding anything that will help us in making early diagnosis of cancer of the lung. It seems to me, however, that we should be able to recognize these differences in the hilus. We should be able to make an adequate examination and be sure whether it is the hilus that is enlarged. In cases in which the hilus appears enlarged on the posterior-anterior projection, I think we must remember that the lesion may be in front of or in back of the hilus and that if it is actually at the hilus it has probably extended beyond the confines of the bronchi. It may be within the lymph nodes, and in any event it is unlikely to be an early carcinoma that is amenable to curative surgery. Of greatest importance is his study of the normal or the control group. If nothing else, this should teach us to go on and do a more complete examination.

Leo G. Rigler, M.D. (*closing*): The hour is late but I don't want to let you leave without emphasizing again the importance of the observation of unilateral enlargement of the hilus shadow in the early diagnosis of carcinoma of the lung. I am a little afraid that Dr. O'Loughlin's stress on measurements may have diverted from the actual point we wish to make; namely, that if one hilus seems enlarged and there is no obvious reason for it, such as tuberculosis or some other cause, then one must strongly suspect carcinoma.

We make lateral views in all of these cases to assure ourselves as to whether there is really a lesion of the lung behind the root or whether it is in the root itself. Given a patient who has no symptoms but with a finding that is suspicious, it always requires a great deal of fortitude to undertake an extensive investigation unless you have something to back it up, and that is where the measurement comes into use.

I just want to report one case by way of illustration to indicate how important is unilateral hilar enlargement. I have shown the film of this case to a number of people and asked them to vote on which side the carcinoma was and have got almost a fifty-fifty result. As one studies the case, it becomes apparent that the left hilus is distinctly enlarged as compared to the right. If you measure it, it really does not help very much, because as we look at the hilus we are thinking of it in terms of the cephalo-caudad enlargement and of the obliteration of the space medial to the hilus.

Now this patient had been seen a year earlier for routine examination of the chest; when one compares the present roentgenogram with the one made earlier, one realizes at once that there has been a marked change in the size of the left hilus.

A third examination was made nine months after the second, and the carcinoma had become perfectly apparent, but the diagnosis should have been made at the time of the second routine examination. If a bronchoscopy or bronchography could have been done at that time, I am sure we would have been able to identify the lesion definitely.

I want to leave you with this thought: We as radiologists have been too casual in regard to unilateral hilus enlargements. It is true in survey films; it is true in clinical cases. The measurement method may help to fix the idea more firmly that an enlargement is present and give us something more substantial to back up our further investigations.

Radiographic Identification of Lymph Node Metastases from Carcinoma of the Esophagus[1]

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Boston, Mass.

THE PAST DECADE has seen the adoption of a more hopeful attitude on the part of the medical profession toward carcinoma of the esophagus. Prior to 1940, malignant lesions of the intrathoracic portion of the esophagus were rapidly fatal despite all methods of treatment by radiation or surgery (4, 17). In 1942, Churchill and Sweet (2) reported the results of resection of the lower portion of the esophagus utilizing a transthoracic approach. By 1944, Garlock (7) and later Sweet (27, 28) had developed a technic for the resection of the upper portion of the intrathoracic esophagus, the main innovation being the anastomosis above the aortic arch of the cut end of the esophagus with the mobilized stomach. Concurrently methods of radiation therapy were also being improved. In 1945, Nielsen (18) reported a significant increase in three-year survivals in patients given rotation therapy. All these developments make the outlook for cure and palliation of esophageal carcinoma slightly brighter.

The prognosis is most favorable when the carcinoma is strictly localized to the esophagus. When it has spread beyond the confines of the esophagus, whether by direct extension into contiguous tissues, hematogenous dispersal, or dissemination through the lymphatic system, curative therapy is difficult and usually ineffectual. To the surgeon or radiologist eager to improve the attack upon carcinoma of the esophagus, a knowledge of the lymphatic drainage system and the possible routes of lymphatic spread is essential. In searching for this knowledge, three questions arise: (1) What factors bear on the frequency of lymph-node metastases? (2) Which lymph nodes are most likely to be invaded in relation to the anatomical site of the primary tumor? (3) What is the radiographic appearance of the lymph nodes when enlarged by tumor?

The purpose of the present investigation is to discover the incidence, evaluate the importance, and point out the salient roentgen diagnostic features of lymphatic dissemination of esophageal cancer.

ANATOMY OF LYMPHATIC SYSTEM OF ESOPHAGUS

The lymph vessels of the esophagus closely parallel the segmental distribution of the vascular system which, being a vital factor in a surgical approach, has been thoroughly studied (26, 29). In this outline, only the usual distribution of the lymph nodes and vessels will be given. Anatomical variations exist, but their nature and incidence are unknown.

One of the earliest studies of the lymphatic system of the esophagus is that made by Sakata (23) in 1903. By the injection of a contrast substance he found that the small lymphatic vessels arose in two sites: the deep layer of the mucous membrane and the muscularis externa. The small vessels arising in the mucosa join in the submucosa to form the larger drainage trunks (Fig. 1) and the vessels originating in the muscularis externa form trunks which traverse the muscular layer (Fig. 2). At a later date, Kuzaya (13) and Kishi (10) confirmed and extended the investigations of Sakata. They not only noted the two major groups of lymphatic channels extending throughout the length of the esophagus but found also that there was direct communication between the two.

It is not known whether valves are present in the lymphatic vessels of the esophagus.

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Accepted for publication in February 1952.

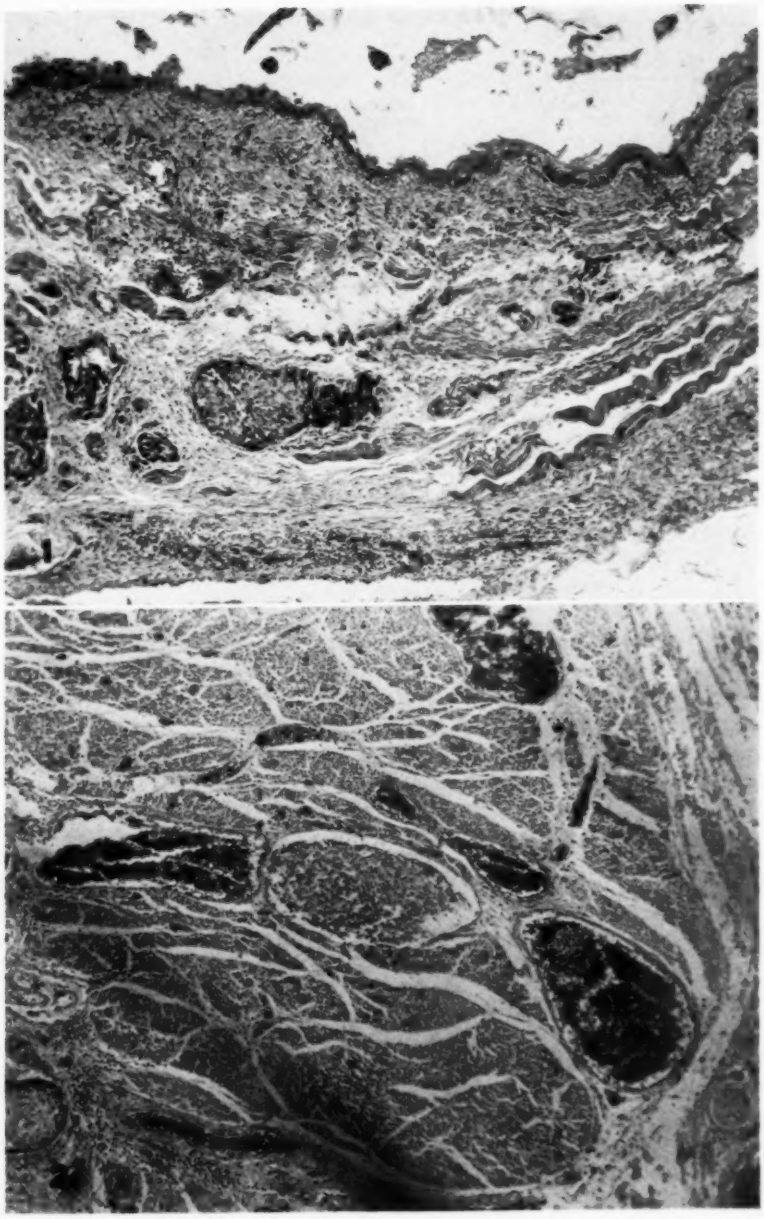


Fig. 1. Lymphatic vessels of submucosa of esophagus (H. E., ×80). This section was taken from the wall of the esophagus adjacent to a carcinoma which had been removed surgically. It shows the submucosal lymphatic vessels distended by a clump of tumor cells which are recognized by their large size and hyperchromatic nuclei. The lymphatic vessels of the submucosa collect the lymph arising in the basal layers of the mucous membrane. These vessels run the length of the esophagus, and at successive levels transport the lymph to the regional nodes.

Fig. 2. Lymphatic vessels of muscular coat (H. E., ×80). This section was taken from a surgically removed esophagus at a point beyond the edge of the tumor. The lymphatic vessel is seen to lie between a vein and artery in the muscular coat. Within this vessel a large cluster of malignant epithelial cells is seen. (There is also a small embolus of tumor cells in the vein to the right of the lymphatic vessel.) The lymphatic vessels of the tunica muscularis carry the lymph derived from the muscular tissue. These channels are in communication with the lymphatic vessels of the submucosa.

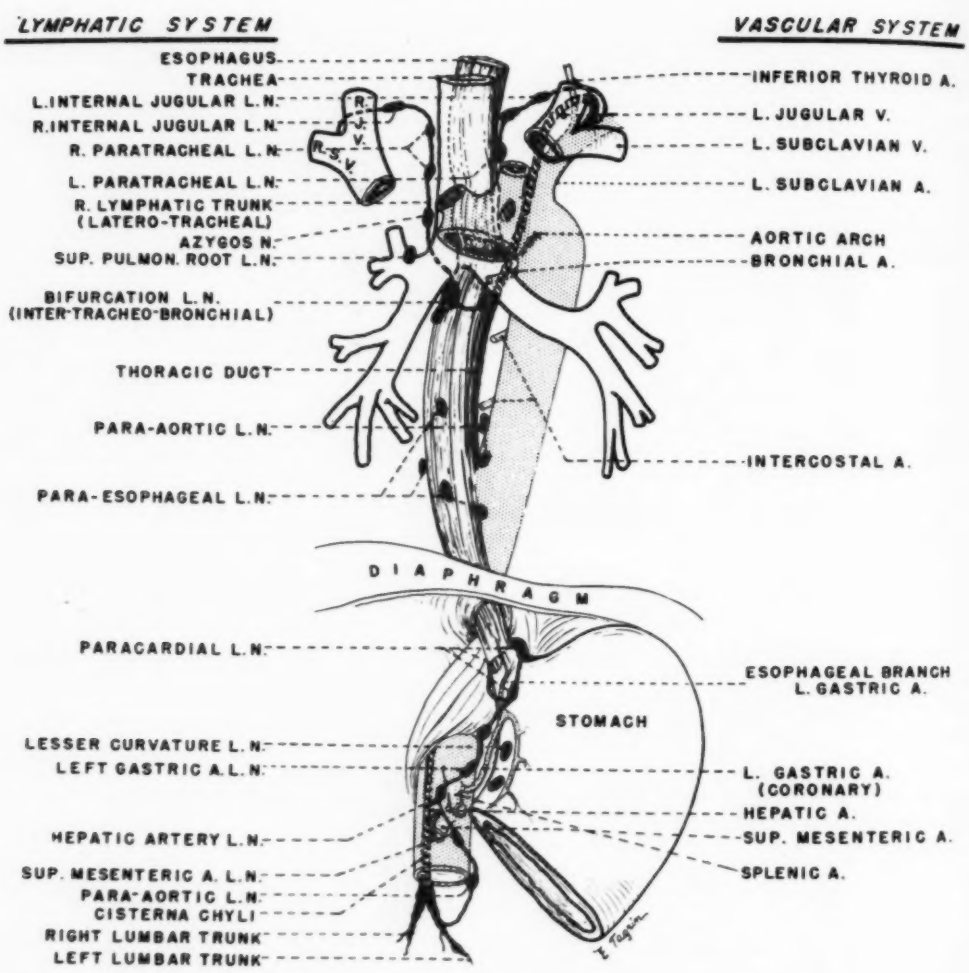


Fig. 3. Diagrammatic representation of lymphatic and vascular system of esophagus. This diagram shows the relationship of the lymph nodes and lymphatic vessels to the esophagus and stomach. The segmental distribution of the lymphatic and vascular network is apparent when the two systems are placed in apposition.

Lymph Nodes: Because of the presence of channels in both the submucosa and muscularis, lymph as well as tumor emboli from any given part of the esophagus may pass outward to the immediately adjacent nodes or may pass longitudinally along the submucous network or the muscular network and reach nodes at some distance (Fig. 3). According to Rouvière (22) and Jossifow (9), the nodes through which lymph from the esophagus passes on its way to the venous system may be enumerated from above downward as follows:

1. The *internal jugular chains of nodes* receive tributary vessels from the cervical and upper thoracic portion of the esophagus. *On the right side,* the lymph from these nodes passes into the right lymphatic duct to enter the venous system; *on the left,* the lymph vessels join the thoracic duct at or near its entrance into the left jugulosubclavian junction.

2. The *paratracheal chains* receive lymph from the upper thoracic esophagus. The *right paratracheal chain* lies adjacent to the right side of the trachea and pos-

terior to the superior vena cava; the lowermost node is known as the azygos node because of its position just above the azygos vein. Efferent vessels from these nodes unite to form the right lymphatic duct. The *left paratracheal chain is* smaller; efferent vessels from it, together with those from the left internal jugular nodes, usually join the thoracic duct at or near the left jugulo-subclavian junction (22).

3. The *nodes of the pulmonary root,* situated between the origin of the major bronchi and the pleural surfaces of the lung, surround the hilus of each lung. Depending on their relation to the hilus, they are divided into four subgroups—superior, inferior, anterior, and posterior. It is the posterior lung root nodes, particularly on the right, which receive lymph from the esophagus. Other pulmonary root nodes are at times found to be involved by metastases, but this may represent a retrograde spread or direct invasion.

4. The *nodes of the tracheal bifurcation* (subcorynal or intertracheobronchial), including the retrotracheal node, receive drainage from the mid portion of the intrathoracic esophagus. The largest node of this chain is situated slightly to the right of the midline. Rouvière (22) has shown in man, and Drinker (5) in the dog, that lymph from these nodes passes mainly to the right paratracheal chain and thence into the right lymphatic duct.

5. The *para-esophageal nodes* receive lymph from the mid section of the esophagus. They are most commonly found from the level of the inferior pulmonary vein to the diaphragm, lying in the loose areolar tissue which surrounds that portion of the esophagus. They are associated with nodes which lie in the adjacent para-aortic area (the para-aortic nodes), and efferent vessels from both pass upward to the nodes of the tracheal bifurcation (22).

6. The *paracardial nodes* encircle the esophagus at the cardiac orifice of the stomach beneath the diaphragm. They receive lymph from the lower esophagus as well as from the fundus of the stomach. From them, the efferent vessels pass to the nodes of the arch of the left gastric artery (8, 10, 29).

7. The *nodes of the lesser curvature of the stomach* are not ordinarily in the direct drainage pathway of lymph from the esophagus, but frequently they are found to be involved by metastases. This may be due to the fact that an extensive collateral circulation has opened up when the lymph drainage to the normal pathways has become blocked.

8. The *nodes of the arch of the left gastric artery* extend from the lesser curvature of the stomach to the celiac axis. Lymph to these nodes comes from the lesser curvature and fundus of the stomach as well as the distal esophagus, areas supplied by the left gastric artery.

The greater portion of the efferent vessels from this chain pass to nodes situated at the base of and inferior to the hepatic artery at the celiac axis. These nodes are posterior to the head of the pancreas and, due to their retroperitoneal position, usually define the limit of surgical extirpation. Efferent vessels therefrom may pass through a few nodes adjacent to the abdominal aorta and then unite to form the intestinal trunk. This trunk, passing to the left of the superior mesenteric artery, joins other lymphatic vessels from the abdominal viscera to form the left lumbar trunk. The latter unites with the right lumbar trunk adjacent to the aorta and just below the diaphragm to form the cisterna chyli.

From the above outline, it is apparent that there are several features of the lymphatic flow from the esophagus which influence the spread of tumor emboli. Lymph from the esophagus can be returned to the venous system by two widely separated pathways. If it passes upward, it traverses the right or left paratracheal lymphatic trunk (more frequently the former) to terminate in the right or left jugulo-subclavian junction. If the lymph passes downward, it follows the course of the left gastric artery beneath the diaphragm, eventually reaching the cisterna

TABLE I: RELATION OF DURATION OF SYMPTOMS TO LYMPH-NODE METASTASES

Duration (months)	Lymph Nodes			
	Positive	Per Cent of Total	Negative	Per Cent of Total
Up to 1	12	15	11	28
1–2	21	41	6	44
2–3	11	55	4	54
3–4	11	69	3	62
4–5	5	75	4	72
5–6	10	87.5	4	82
6–7	0		2	87
7–8	2	90	1	90
Over 8	8	100	4	100
TOTAL	80		39	

chyli, and from this point it travels *via* the thoracic duct into the left jugulo-subclavian junction.

MATERIAL AND METHODS OF INVESTIGATION

The present work is based on a study of 312 consecutive patients with carcinoma of the esophagus admitted to this hospital between Jan. 1, 1943, and Jan. 1, 1951. Of this number, 201 (64.9 per cent) were submitted to exploratory operation; in 130 (42 per cent) it was possible to resect the primary tumor. Histologic examination in the cases selected for surgery revealed that 122 (61 per cent) had metastatic deposits in the regional lymph nodes; in 59 (29 per cent) the lymph nodes were free of disease; and in 20 (10 per cent) the presence or absence of lymph-node metastases could not be accurately determined.

That the lymphatic system plays an important role in the spread of carcinoma of the esophagus is indicated by the fact that in 61 per cent of 201 patients, selected in the belief that their tumors might be resectable, it was found that metastases had already occurred. A high incidence of lymph-node metastases has also been reported at postmortem examinations (1, 4, 20).

The group selected for detailed analysis consisted of 119 patients, of whom 80 had metastases to lymph nodes. Criteria for this selection were completeness of the preoperative roentgenographic study and of the surgical exploration. Cases in which the preoperative roentgenograms were not available and those in which the search for metastases was limited were excluded.

In the majority of this selected group, the primary tumor as well as the lymph nodes were removed. The latter, if not removed, were biopsied. In recent cases metal clips were placed in the unresectable nodes so that their position would be registered on postoperative roentgenograms (Fig. 15). It has been stressed previously (3, 15) that surgical palpation is not an absolutely reliable method of determining lymph-node metastases. The observations of Saphir and Amromin (24), that in carcinoma of the breast every lymph node in the drainage area must be subjected to careful study by serial sections in order to exclude metastases, applies equally to carcinoma of the esophagus. Furthermore, surgical exploration is seldom complete, particularly in the presence of metastases in the opposite side of the chest or in the retroperitoneal area. Despite the limitations of the method of investigation, the information obtained has served as a stimulus for continuation of the studies and has provided another means of evaluating the extent of the disease.

TABLE II: GRADE OF MALIGNANCY OF TUMOR IN RELATION TO LYMPH-NODE METASTASES

Type Tumor	No.	Classification	Lymph Nodes	
			Positive	Negative
Squamous	117	Grade I	1	0
		Grade II	15 (18%)	17 (43%)
		Grade III	41 (50%)	17 (43%)
		Grade IV	6	1
		Undiffer.	0	2
		Ungraded	15 (18%)	2
Mixed	1		1	
Colloid	1		1	
TOTAL	119		80	39

ANALYSIS OF THE GROUP STUDIED

The age and sex incidence does not differ from other large reported series (19). Comparison of the *duration of symptoms* with the presence or absence of lymph-node metastases (Table I) indicated no obvious correlation between the two fac-

tors. Fifty-five per cent of the positive group and 54 per cent of the negative group sought medical advice within three months of the recorded onset of symptoms.

Squamous-cell carcinoma was the predominating type of tumor (Table II). Only two exceptions were encountered:

TABLE III: RELATION OF SIZE* OF TUMOR TO LYMPH-NODE METASTASES

Size of Tumor (Length in cm.)	Lymph Nodes	
	Positive	Negative
Up to 1.9	0	1
2–2.9	3	6
3–3.9	11	1
4–4.9	22	7
5–5.9	10	8
6–6.9	8	4
7–7.9	9	8
8–8.9	7	2
9–9.9	4	1
Over 10	6	1
TOTAL	80	39

* The size of the tumor was estimated by direct measurement of the length as visualized on the 6-foot chest roentgenogram.

one was a mixed type and the other a colloid carcinoma.

The histologic *grade of malignancy of the tumor* may influence the presence or absence of lymph-node metastases. In the cases investigated, Grade I was extremely rare and Grade IV was not common; the majority of the lesions were of Grades II and III (Table II). Of those with metastases, 50 per cent were classified as Grade III and 18 per cent as Grade II, while the group without lymph-node metastases was equally divided between Grades II and III. In the lower grade of malignancy, therefore, there is less likelihood of early lymph-node metastases.

An attempt to correlate the *over-all size of the lesion* with the presence or absence of lymph-node metastases (Table III) was made. The size was estimated by direct measurement of the length of the tumor from the chest roentgenogram. Fleming (6), in an autopsy study of 52 patients untreated during life, found that 95 per cent of those with tumors longer than 5.1 cm. had evidence of lymph-node metastases or distant spread. No correlation, however, could be found in this series between the over-all length of the tumor and the presence or absence of lymph-node metastases. This may be due to the small size of the group studied, to the fact that only one measurement of a three-dimensional tumor was made, and to possible inaccuracy of measurement. The length of the tumor was taken as the distance between the margins of the deformed barium column in the esophageal lumen (the so-called shelf). But this does not strictly represent the degree of submucosal extension, a characteristic of carcinoma of the esophagus. Fleming was able to measure the length of the tumor at autopsy with greater accuracy. It is impossible, therefore, to predict with any certainty the presence or absence of lymph-node metastases on the basis of the radiographically determined length of the lesion. A relatively small tumor may be attended by early lymph-node metastases.

TABLE IV: RELATION OF ANATOMICAL SITE OF PRIMARY TUMOR TO LYMPH-NODE METASTASES

		Segmental* Site of Primary Tumor				
		I	II	III	IV	Total
No. Cases with Metastases		2	15	37	26	80
Lymph Nodes Involved†						
Above Diaphragm	Right or left int. jugular	1	3	2	0	6
	Right paratracheal	1	1	4	0	6
	Left paratracheal	1	1	1	1	4
	Bifurcation	1	7	8	3	19
	Pulmonary root	0	1	3	0	4
	Para-esophageal and/or para-aortic	0	8	26	20	54
	TOTAL	4	21	44	24	93
Below Diaphragm	Paracardial	0	1	12	11	24
	Arch left gastric artery and/or lesser curvature	0	3	10	13	26
	Celiac axis	0	1	3	1	5
	Retroperitoneal	0	1	3	2	6
	TOTAL	0	6	28	27	61
TOTAL LYMPH-NODE INVOLVEMENT		4	27	72	51	154

* Intrathoracic portion of esophagus arbitrarily divided into four segments.

† The number given for each lymph-node chain is based on the operative findings. In the majority of cases this was confirmed by histologic examination of the resected specimen.

The morphology of carcinoma of the esophagus may vary considerably. Schatzki (25) recognized three main types: the constricting scirrhous tumor, the infiltrating type with secondary ulceration, and

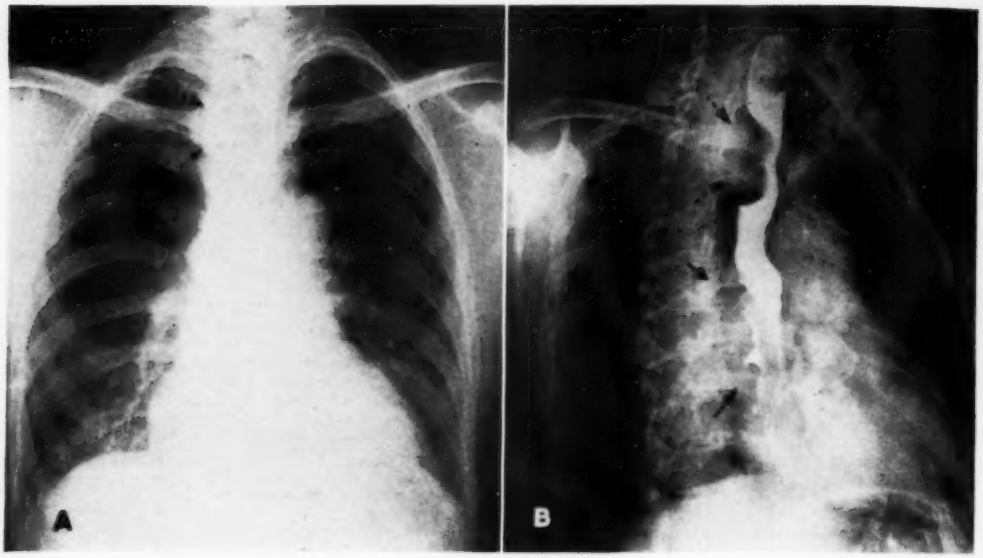


Fig. 4. Right paratracheal lymph nodes. The patient was a 65-year-old white woman, admitted with difficulty in swallowing of eighteen months duration. *Roentgen examination* disclosed a large irregular tumor in the third segment of the esophagus, beginning at the level of the tracheal bifurcation and extending downward for a distance of 9 cm. (solid arrows). The extent of this tumor with its large central ulceration is well shown in the right anterior oblique projection (B). In addition, enlarged lymph nodes are seen in the right superior mediastinum. On the postero-anterior chest roentgenogram (A) these nodes, which are slightly nodular in outline (dotted arrows), are seen to indent the right lateral margin of the trachea and esophagus.

At operation, it was found that the enlarged nodes which indented the right side of the esophagus and trachea were involved by metastatic tumor. For this reason, resection was not carried out.

In this and subsequent illustrations the solid arrows designate primary tumor, the dotted arrows enlarged lymph nodes.

the polypoid, cauliflower-like tumor. In the present series no correlation between the type of tumor and the presence of metastases was evident.

Considerable interest attaches to the relation between the site of the primary tumor and the site of the lymph-node metastases (Table IV). To facilitate this investigation, the intrathoracic portion of the esophagus was arbitrarily divided into four approximately equal segments. *Segment I* extends from the plane of the thoracic inlet to the upper margin of the aortic arch. *Segment II* extends from this point to the bifurcation of the trachea. *Segment III* covers the area between the bifurcation and the level of the inferior pulmonary vein. *Segment IV* constitutes the remainder of the esophagus, that is, from the level of the inferior pulmonary vein down to the diaphragm. These segments correspond more or less to the four zones of the thoracic esophagus described by Churchill and Sweet in 1942 (2). This subdivision, a purely arbitrary one, serves, for the purposes of this study, as a means of tabulating the location of the greater portion of the primary tumor.

In all cases, the frequency of the lymph-node involvement noted in Table IV is based on the operative findings. When the suspected lymph nodes were removed with the specimen, they were studied histologically. Where resection and lymphadenectomy were not possible, a biopsy of one or more nodes from suspected groups was obtained. The limitations of this method of investigation are appreciated. The number of lymph-node metastases recorded is unquestionably less than the number actually present, since only by study of serial sections of all the lymph nodes in the drainage pathways can the presence of metastases be ruled out. Cer-

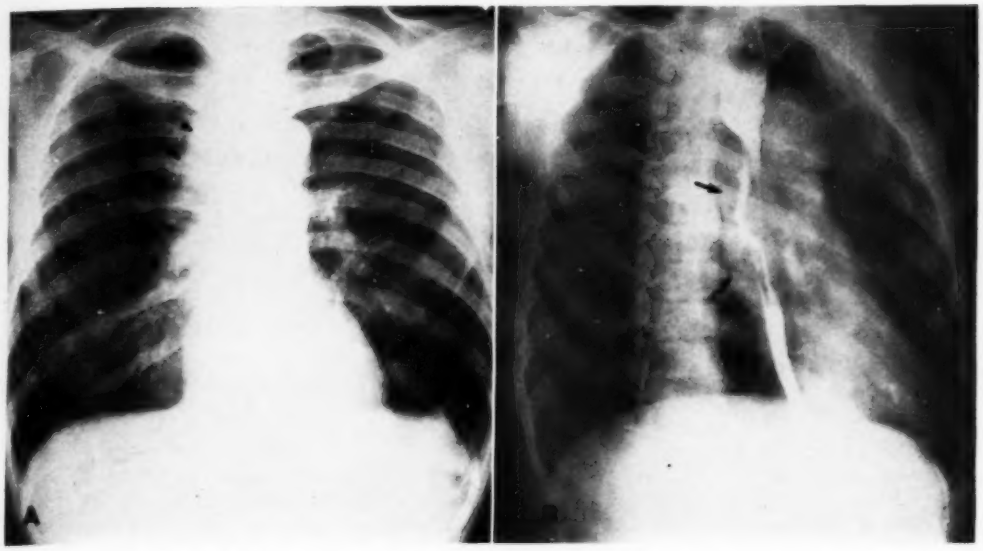


Fig. 5. Nodes of the right pulmonary root and right paratracheal chain. A 50-year-old colored male had experienced dysphagia for the preceding three weeks. A *barium swallow* disclosed the presence of an ulcerating, constricting lesion in the mid-esophagus extending from the level of the superior margin of the aortic arch downward for a distance of 10 cm. The primary tumor (solid arrows) is best shown in the right anterior oblique view (B). On the postero-anterior roentgenogram (A) enlarged lymph nodes (dotted arrows) are seen adjacent to the right side of the trachea and at the superior margin of the right pulmonary artery.

At operation, the primary tumor was discovered lying behind the aorta with large metastatic lymph nodes extending into the superior mediastinum. The lesion was considered to be inoperable; biopsy was obtained.

tain pertinent observations can, however, be made from the data in Table IV.

1. When the primary lesion involves the midthoracic esophagus there may be a slightly greater tendency for the disease to spread to the right than to the left paratracheal nodes.

2. When the tumor is situated in the third and fourth segments of the esophagus, there is a high incidence of involvement of the para-esophageal lymph nodes.

3. The lower the level of the tumor in the esophagus, the more likely there are to be lymph-node metastases beneath the diaphragm (27).

ROENTGEN EXAMINATION AND DIAGNOSIS

Experience has shown that any patient over forty who complains of dysphagia should have the advantage of radiographic examination of the esophagus (14). Furthermore, the examination should not be considered complete until every segment of the esophagus has been thoroughly studied. It may be necessary to carry out repeated examinations. Only by this means can the relatively early esophageal carcinoma be brought to treatment.

Prior to roentgenoscopic examination of the chest, two preliminary steps have been found to be of value: (*a*) careful palpation of the lower cervical area to determine the presence or absence of enlarged nodes of the right and left internal jugular chains; (*b*) fluoroscopic observation of the movement of the vocal cords. Following this, the contour of the mediastinum, the clarity of the lung fields, and the motion of the diaphragm are determined.

A simple mixture of half barium and half water has been found to give excellent results. The patient, after swallowing the mixture, is examined in both the erect and Trendelenburg positions through all degrees of obliquity. An attempt is made to study the mucosal relief after the method of Schatzki (25). The carcinoma may ap-

Fig. 6. Bifurcation lymph nodes. A 61-year-old white male was admitted, complaining of difficulty in swallowing for seven months. The *barium examination* revealed a constricting lesion in the fourth segment of the esophagus, 5 cm. in length and characterized by a shelf defect on its superior margin (solid arrows). On the right anterior oblique roentgenogram, enlarged bifurcation lymph nodes are visualized. These nodes indent the inferior border of the right main bronchus and compress the esophagus, displacing it posteriorly (dotted arrows).

At operation, the tumor was found in the lower segment of the esophagus, and there was a cluster of enlarged hard lymph nodes in the subcorynal area adherent to both the right and left main bronchi. These nodes, removed with the primary tumor, contained metastases.

pear as a fungating mass, a large ulcer, or a constricting tumor. In the presence of the last, food may be impacted above the area of constriction, causing multiple filling defects in the lumen. When this situation exists, it is best to discontinue the examination, insert a tube in the esophagus, and adequately aspirate the contents (which may take several days), after which the examination should be repeated. While most carcinomas of the esophagus are easily demonstrable, a small early one may present considerable difficulty. Since it is this type which is most likely to be amenable to surgical extirpation, even the slightest alteration in the normal mucosal pattern of the esophagus should be regarded with suspicion. If repeated study fails to define the nature of this alteration, immediate esophagoscopy and biopsy are indicated.

When the location and nature of the primary tumor have been discovered, attention is turned to the possibility of lymph-node metastases. Knowledge of the normal anatomical pathways is of considerable aid to the examiner.

The value of the roentgenographic search of the thorax and abdomen for lymph-node metastases is predicated on one condition: that the lymph node which is the seat of metastasis will become larger than normal. It is quite obvious that the first small cluster of embolic tumor cells to lodge in the marginal sinus of the lymph node will cause no enlargement of its host organ. Only when the tumor cells have multiplied, will enlargement of the node take place. Therefore, the visualization of nodes enlarged by tumor indicates that the process has been established for some time prior to examination. An enlarged lymph node is not always the seat of metastatic cancer. Infection secondary to an ulcerated growth will cause enlargement of nodes which may be indistinguishable, even by palpation, from metastatic tumor.

Enlargement of the cervical lymph nodes is determined by palpation. Preoperative detection of enlargement of all other lymph-node chains is dependent upon careful roentgenographic technic.

1. The *right paratracheal chain of nodes* will be visualized because, when enlarged, they tend to project into the aerated right lung (Fig. 4). As they increase in size they will indent both the trachea and esophagus. The azygos node, the lowermost of this chain, is an important anatomical landmark. It lies just superior to the azygos vein.

2. The lymph nodes of the right and left *lung root*, which surround the pulmonary veins, pulmonary artery, and main bronchus at the hili, are difficult to delineate because of their close association with the dense vascular structures. This is particularly true of the posterior nodes, which are most commonly involved. The superior pulmonary root node is identified

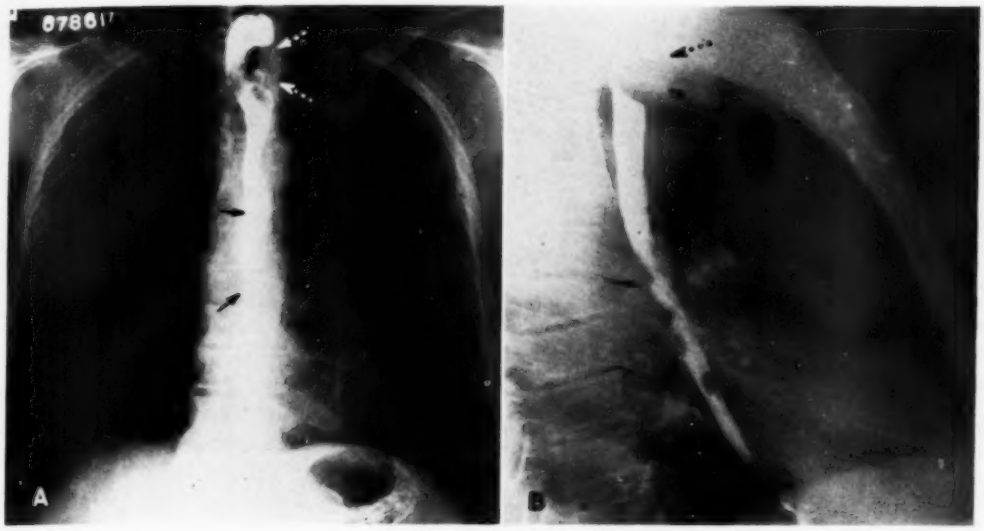


Fig. 7. Left paratracheal lymph nodes. A 66-year-old white male had experienced progressive dysphagia and hoarseness for five weeks prior to admission. A *barium swallow* disclosed the presence of an ulcerating, constricting tumor, which extended downward from the level of the tracheal bifurcation for a distance of 6 cm. This is seen on the postero-anterior grid (A) and lateral (B) roentgenograms (solid arrows). A soft-tissue tumor in the left paratracheal area was also observed. It compresses and indents the left side of the trachea as well as the left side of the esophagus. This is believed to represent enlargement of the left paratracheal lymph nodes (dotted arrows). Because of this evidence of lymphatic spread, as well as of left vocal cord paralysis, the patient was not explored.

Esophagoscopic examination confirmed the presence of a carcinoma, on which a biopsy was done. At the same time, pressure on the left side of the esophagus from enlarged left paratracheal nodes was noted.

with slightly less difficulty because it projects above the superior margin of the pulmonary artery into the aerated lung (Fig. 5).

3. The *nodes of the tracheal bifurcation* show a high incidence of involvement, particularly in tumors of the esophagus originating at or near the level of the bifurcation (Table IV). Enlargement of these nodes should be suspected when a soft-tissue tumor is seen projecting into the medial border of the right lung below the bifurcation (Fig. 6), or when the barium-filled esophagus is indented or even displaced posteriorly by the mass of nodes at the bifurcation. Roentgenograms taken in the right and left anterior oblique positions are most helpful. Indentation or displacement of the esophagus is best demonstrated when it contains only a small amount of barium; over-distention with barium may obscure slight enlargement of the lymph nodes. Another sign of diagnostic value in enlargement of the bifurcation nodes is the occurrence of indentation of the under surface of either the right or left main bronchus. This should also arouse suspicion that the bronchial wall may have been invaded.

4. Demonstration of the *left paratracheal chain of lymph nodes* offers considerable difficulty because they lie behind the arch of the aorta and the left subclavian artery. When sufficiently enlarged, they will indent the left lateral margin of the trachea and esophagus (Fig. 7). Since they lie adjacent to the left recurrent laryngeal nerve, paralysis of the left vocal cord may result from invasion by these enlarged nodes. Examination of the vocal cords is therefore important. In the presence of a carcinoma of the esophagus, paralysis of the left cord suggests involvement of the nerve by direct extension of the tumor or by lymph node metastases (16).

5. The *para-esophageal lymph nodes*,

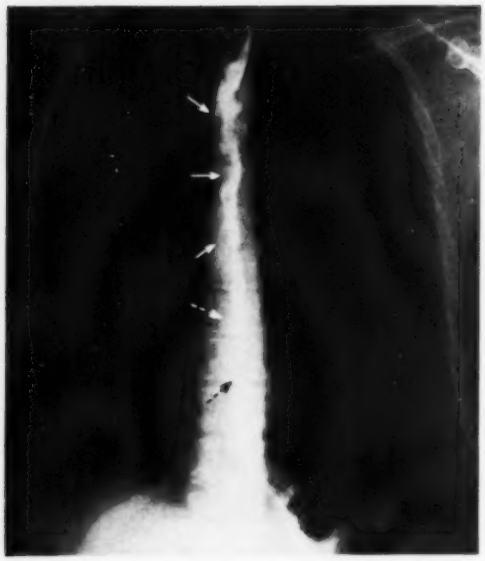


Fig. 8. Para-esophageal lymph nodes. A 49-year-old white male was admitted with a history of difficulty in swallowing for five months. *Barium examination* revealed a constricting lesion beginning just below the thoracic inlet and extending downward for a distance of 10.5 cm. to the tracheal bifurcation. The primary tumor is well shown in postero-anterior grid roentgenogram (solid arrows). A cluster of enlarged lymph nodes is seen adjacent to the right lateral margin of the lower esophagus at the level of the inferior pulmonary vein (dotted arrows). Visualization is possible because the mass is surrounded by the aerated right lung which forms the right lateral margin of the esophagus. (For purposes of reproduction, the right lateral margin of the lymph nodes has been lightly retouched.) The mucosal folds in this area are somewhat smoothed out due to pressure by these nodes.

At operation, the tumor was found in the region of the aortic arch and, because of extension into the para-esophageal lymph nodes and adjacent mediastinal tissue, was considered unresectable.

located in the surrounding areolar tissue at the level of the inferior pulmonary vein, show a high incidence of involvement (Table IV). If, as frequently happens, they lie immediately adjacent to the primary tumor, the roentgen outline of the latter and the included lymph nodes will have a grossly nodular margin and the pathologic specimen will exhibit the nodes as nodular projections on the outer surface of the tumor. When the enlarged nodes lie to the right of the esophagus, they will be surrounded by the aerated right lung, which forms the lateral margin of the esophagus (Fig. 8). They may also indent the border of the esophagus, causing a flattening and stretching of the overlying mucosal folds. When the involved nodes are on the left border of the esophagus, they are obscured by the descending thoracic aorta.

6. The *paracardial lymph nodes* lie entirely beneath the diaphragm, forming a ring around the cardia. A contrast substance, either air or barium, introduced into the stomach will demonstrate their enlargement. The simplest and easiest method of introducing air has been for the patient to drink a glass of carbonated beverage. Air introduced *via* a stomach tube or a Seidlitz powder also serves this purpose. If the patient is then examined in the erect position, enlarged paracardial lymph nodes will be seen interposed between the diaphragm and the air-filled cardiac region of the stomach (Figs. 9–12). Roentgenograms taken in the right anterior oblique position are valuable, for in this projection the subdiaphragmatic portion of the esophagus and fundus of the stomach are seen in profile. With barium in the stomach, the cardia and fundus are also examined in the prone and supine positions to detect enlargement of the paracardial nodes (Fig. 11).

7. At the time air is introduced into the stomach, search is made also for the *nodes of the arch of the left gastric artery*, as well as for the *nodes at the lesser curvature*. When enlarged, these nodes will indent the body of the stomach along the lesser curvature below the cardia (Figs. 13 and 14). Here again it is necessary to examine the patient in both the upright and recumbent positions and, at times, in right and left lateral decubitus.

8. Because of their retroperitoneal position, the *nodes of the celiac axis and the lower para-aortic region* are difficult to demonstrate; only when they have reached an extremely large size is this possible. By the time this has occurred, other manifestations have, as a general rule, made it clear that the tumor is inoperable and incurable.

Two other roentgen observations may

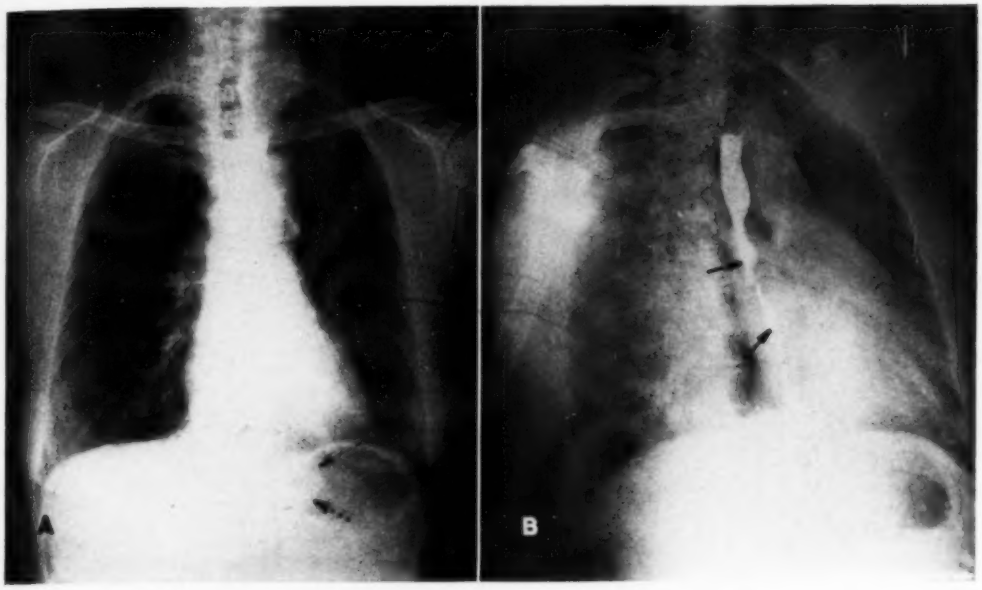


Fig. 9. Paracardial lymph nodes. A 77-year-old white woman was admitted because of four months difficulty in swallowing food. *Barium examination* disclosed an ulcerating lesion in the third segment of the esophagus, beginning at the tracheal bifurcation and extending downward for a distance of 9 cm. This is best shown (solid arrows) on the right anterior oblique roentgenogram (B). In addition, a cluster of enlarged paracardial lymph nodes indents the medial margin of the air-filled fundus of the stomach (dotted arrows). This is shown on the postero-anterior projection (A) as well as on the spot film (C) of the fundus of the stomach, taken in a slightly right anterior oblique position with the patient upright (dotted arrows).

At operation, the primary tumor was found in the middle of the esophagus. Because of a large mass of lymph nodes, present in the region of the left gastric artery, invading the stomach at the cardiac orifice as well as on the lesser curvature side, the lesion was considered unresectable.

indicate the extent of the malignant involvement. The first concerns the possible invasion of the posterior tracheal wall or the right or left main bronchus, either of which, according to present standards, renders the tumor inoperable. A fistula is clear evidence that this has occurred; a nodular irregularity or a compression of the wall of these air-filled structures is suggestive (Fig. 10). In such instances bronchoscopic examination should be carried out prior to surgery. The second is the demonstration of a pocket of fluid or air in the mediastinum; this is probable evidence of a mediastinal abscess.

In order to delineate both the primary tumor and enlarged intrathoracic and subdiaphragmatic lymph nodes, four routine roentgenograms of the chest have been utilized, postero-anterior, lateral, right and left anterior oblique, taken at a 6-foot distance. These are obtained with the

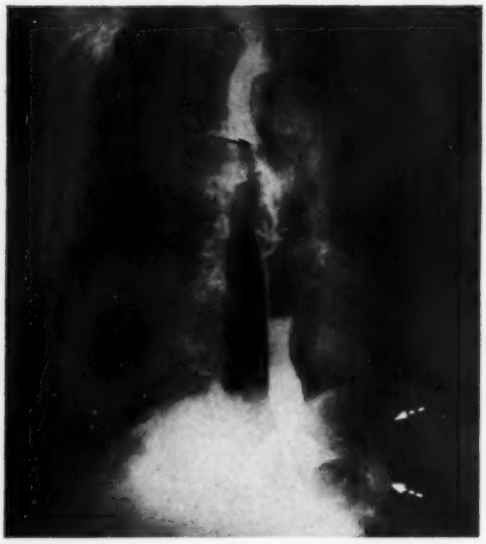


Fig. 10. Paracardial lymph nodes in a 77-year-old white male whose symptoms of dysphagia had been present for eight months. A *barium examination* revealed an ulcerating and fungating lesion involving the mid-esophagus beginning at the level of the inferior margin of the aortic arch and extending downward for a distance of 8 cm. The tumor shows a shelf defect at both margins; this is illustrated on the right anterior oblique roentgenogram (solid arrows). Nodular irregularity of the inferior margin of the left main bronchus suggests the possibility of invasion. A mass of enlarged paracardial lymph nodes surrounds the lower end of the esophagus at the cardia and indents the air-filled fundus of the stomach (dotted arrows). The patient died shortly after admission to the hospital.

Autopsy revealed epidermoid carcinoma, Grade 3, of the middle third of the esophagus with metastases to the paracardial lymph nodes and invasion of the fundus of the stomach. Direct invasion of the left main bronchus had also occurred and the liver was involved by metastatic tumor.

patient in the upright position, the esophagus being outlined by the smallest amount of barium possible and the fundus of the stomach distended by gas. A high kilovoltage (90–125) with a stationary grid is used. This gives sufficient penetration to delineate the air-filled trachea and major bronchi, particularly the tracheal bifurcation. In addition, it makes possible visualization of the fine line formed

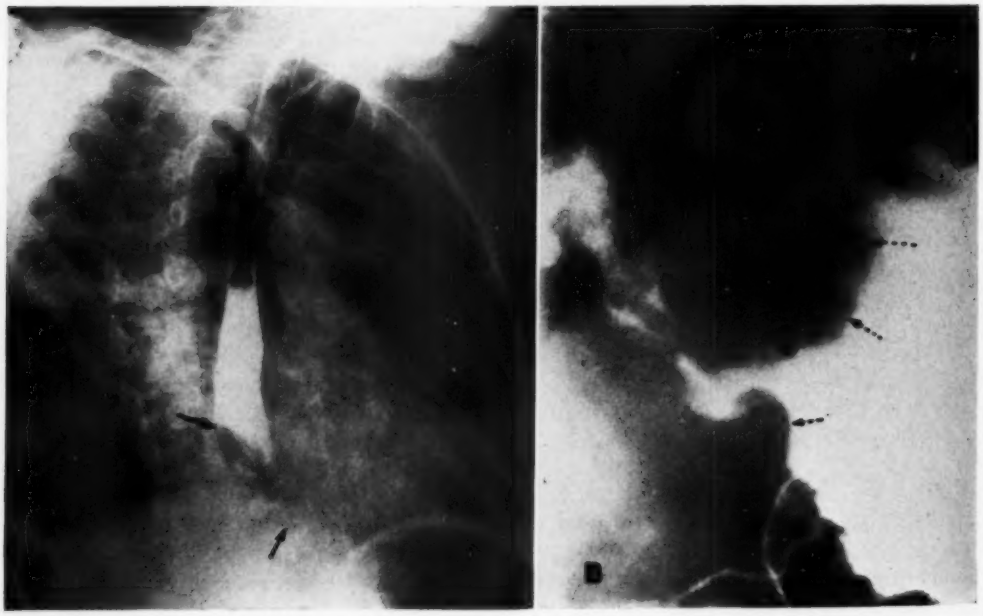


Fig. 11. Paracardial lymph nodes. A 61-year-old white male had experienced difficulty in swallowing over a period of four months. A large fungating tumor in the fourth segment of the esophagus is demonstrated (solid arrows) on the right anterior oblique roentgenogram (A). A spot film taken in the supine position (B) shows an irregular filling defect in the fundus of the stomach below the diaphragm (dotted arrows).

At operation, the primary tumor, situated in the lower end of the esophagus but not extending beneath the diaphragm, was removed, as were the lymph nodes in the paracardial area. Histologic examination revealed a squamous-cell carcinoma, Grade 3, with metastases to four of the six resected nodes.

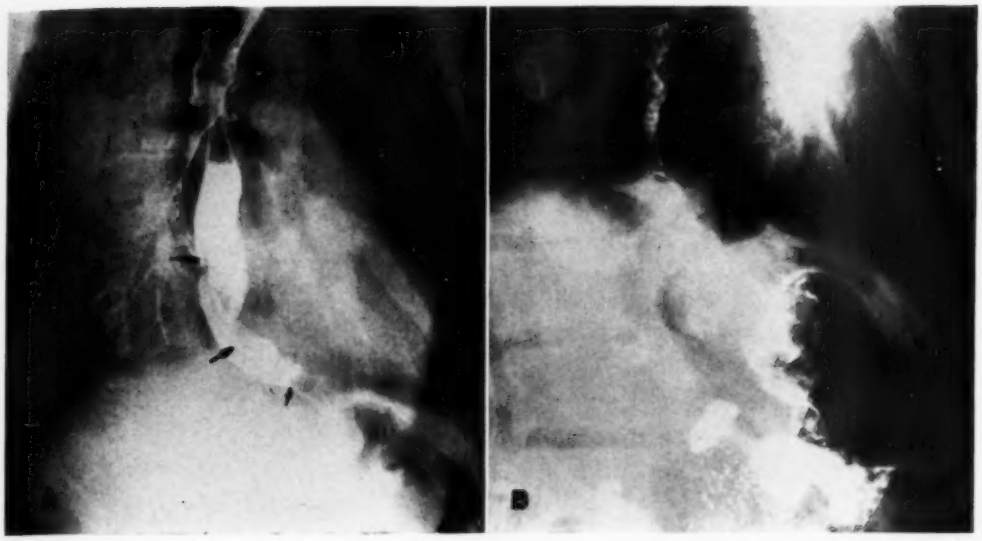
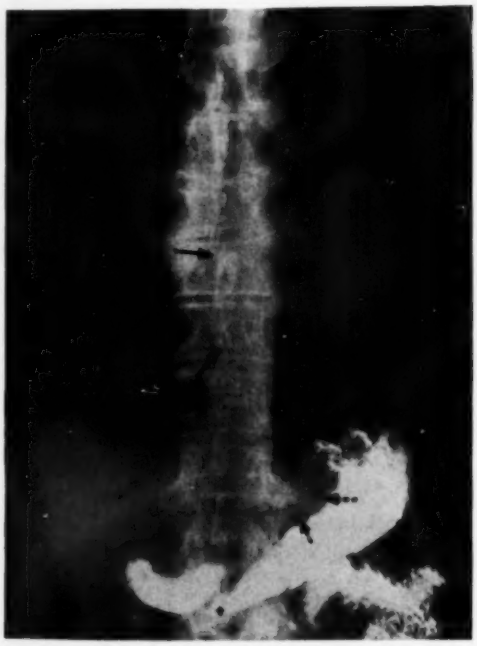


Fig. 12. Paracardial lymph nodes. A 68-year-old white male had complained of dysphagia for one week. *Roentgen examination* disclosed an irregular, constricting lesion in the fourth segment of the esophagus, extending downward for a distance of 6 cm. This is best seen (solid arrows) in the erect right anterior oblique roentgenogram (A). Because of a prior and unrelated laryngeal tumor, there was some spilling over of the barium into the tracheobronchial tree. On a right anterior oblique projection taken in the prone position (B) enlarged paracardial lymph nodes are visible, indenting the stomach in the region of the cardia (dotted arrows).

At operation, the primary tumor was found in the lower end of the esophagus. When the diaphragm was opened, the stomach appeared to be normal, but there were many hard, apparently involved lymph nodes around the cardia and left gastric vessels. Histologic study revealed epidermoid carcinoma, Grade 2, with massive metastases to the resected lymph nodes.



by the barium-filled esophagus against the medial border of the right lung. When indicated, spot films of the esophagus and stomach are taken during fluoroscopy.

RELATIONSHIP OF LYMPH-NODE METASTASES TO PROGNOSIS

In any cancer of the body, the success or failure of therapy is strongly modified

Fig. 13. Nodes of left gastric artery and lesser curvature. A 67-year-old white male had been ill for eight weeks, complaining of dysphagia. The *roentgen examination* disclosed a relatively small lesion, 5.5 cm. in greatest length, in the fourth segment of the esophagus. A shelf defect is apparent superiorly and inferiorly. The postero-anterior projection taken in the prone position shows the primary tumor (solid arrows) and also a nodular indentation on the lesser curvature side of the stomach adjacent to the left gastric artery (dotted arrows), due to enlargement of the left gastric artery nodes.

At operation, a transthoracic resection of the esophagus and stomach with esophagogastric anastomosis was performed. The tumor was relatively small but was completely annular and had destroyed the wall of the esophagus. There was a large hard node lying directly on the tumor and similar positive nodes were noted in the region of the left gastric vessels.

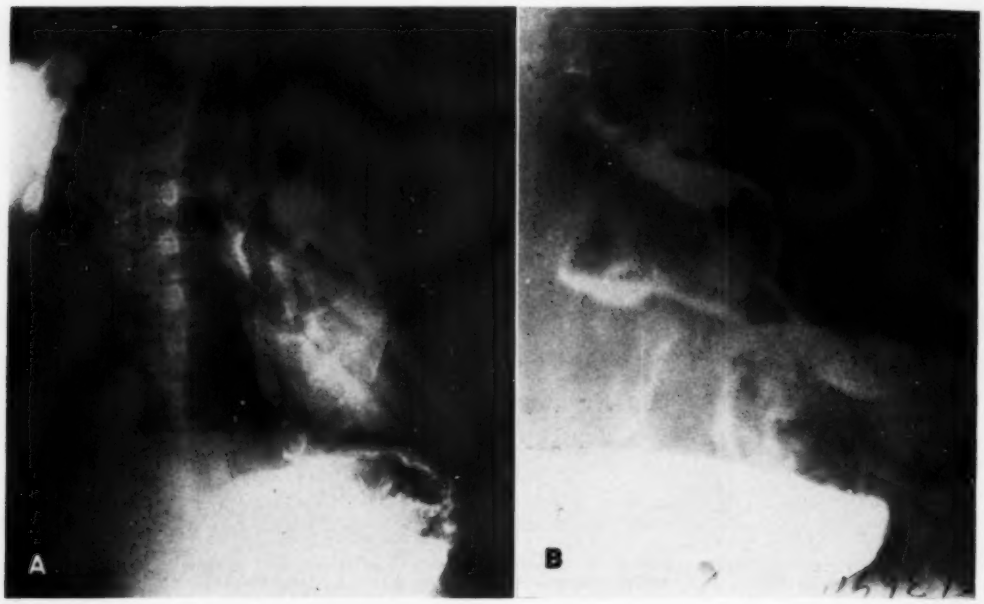


Fig. 14. Paracardial and left gastric artery lymph nodes. A 62-year-old white male entered the hospital two months after the onset of dysphagia. The *roentgen examination* disclosed the presence of a tumor beginning at the superior margin of the aortic arch and extending downward for a distance of 9 cm. The right anterior oblique roentgenogram (A) shows the primary tumor (solid arrows) accompanied by enlargement of the bifurcation lymph nodes. A right anterior oblique projection centered over the fundus of the stomach in the upright position (B) shows a nodular indentation along the lesser curvature of the stomach just below the cardia due to enlargement of the paracardial and left gastric artery lymph nodes (dotted arrows).

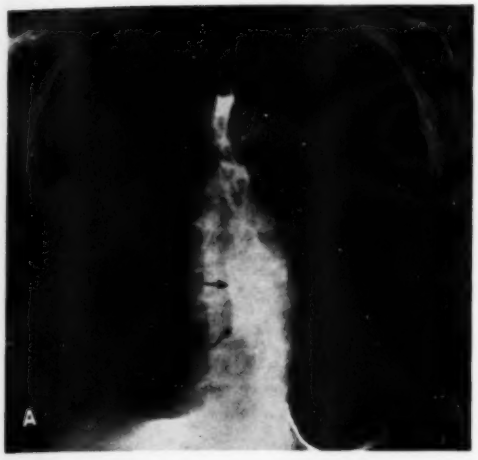
Exploratory thoracolaparotomy revealed the primary tumor in the lower mid-esophagus and involved lymph nodes in the region of the tracheal bifurcation. A short incision in the diaphragm disclosed a large mass of metastatic lymph nodes in the region of the left gastric vessels, extending behind the pancreas. The lesion was considered inoperable. Lymph node biopsy on histologic examination showed squamous-cell carcinoma.

by the presence or absence of lymph-node metastases (31). Esophageal cancer is no exception. Out of 174 patients selected by Sweet (30) for surgical resection, 42 per cent were without and 57.5 per cent with lymph-node metastases. In the negative-node group of patients, the five-year survival was 40 per cent; in the involved-node group, it was 13.5 per cent.

Reported series of surgically treated patients have been rigidly selected, and it is to be expected, therefore, that the percentage of five-year survivals is higher than in groups treated with radiation. It is worth pointing out, however, that the technic of surgical resection as outlined by Garlock (7), Sweet (27, 30), and Resano (21) entails the removal of the accessible lymph nodes above and below the diaphragm. Since these nodes may be at a distance from the site of the primary tumor, they would not ordinarily be included in the field of irradiation. Radiation can be expected to cure the primary lesion in some cases (32), and cure of the patient may follow if no lymph nodes have become involved by metastases. When lymph-node metastases are demonstrated roentgenographically by enlargement of the nodes, only surgery has, up to the present, proved capable of dealing effectively with both the primary and secondary growths. Whether the newer methods of radiation therapy, with voltages of two million and over, will be able to control them as successfully remains to be investigated.

SUMMARY

1. This report is based on 119 selected cases of carcinoma of the esophagus



phatic drainage system of the esophagus makes it apparent that tumor emboli may be carried by lymphatic vessels to the nearest chain of lymph nodes or may be deposited at a distance from the primary tumor. The reason for this is that the collecting vessels, present in the submucosa and in the tunica muscularis of the esophagus, extend throughout its entire length, and not only intercommunicate but also communicate with afferent vessels of the regional lymph nodes at successive levels of the esophagus.

3. In the group studied, no relationship was found between the stated duration of symptoms and the presence or absence

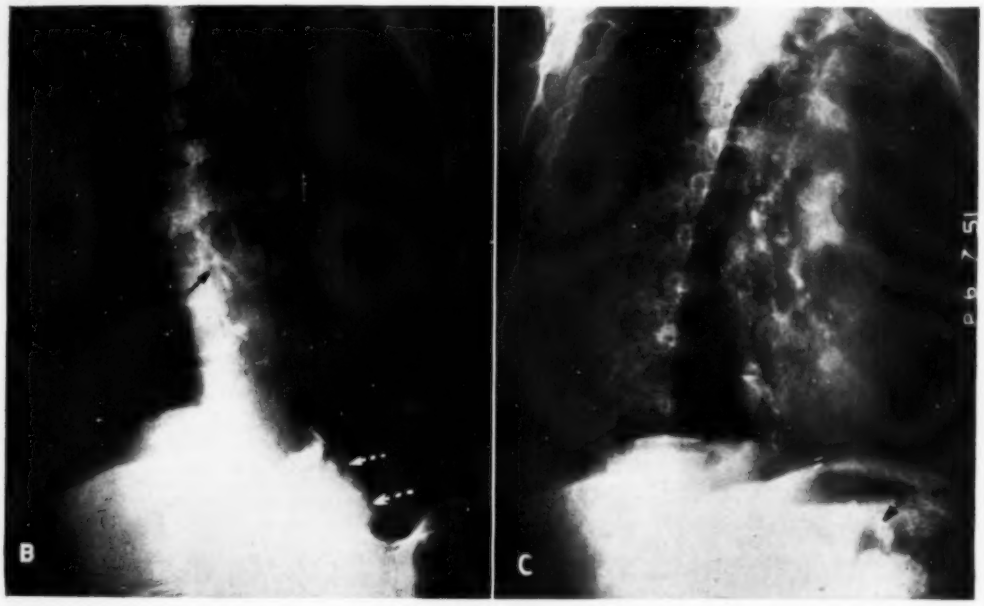


Fig. 15. Paracardial and left gastric artery lymph nodes. This patient had had difficulty in swallowing and hoarseness for two months. The *postero-anterior roentgenogram* (A) shows an ulcerating tumor 10 cm. in length in the middle of the mid thoracic esophagus (solid arrows). A right anterior oblique roentgenogram (B) also shows the primary tumor (solid arrows). In the region of the cardia and on the lesser curvature side of the gas-filled stomach there is indentation caused by enlargement of the paracardial and left gastric lymph nodes (dotted arrows).

At esophagoscopy, the left vocal cord was found fixed in the mid line, and the coryna wide and fixed. Because there was both radiographic and endoscopic evidence of lymphatic spread, resection was not attempted. Subsequently, when a Spivak gastrostomy was performed, nodes in the paracardial region and along the lesser curvature side of the stomach were found to be massively enlarged and filled with tumor. One of these nodes was removed for biopsy; two small metal clips were inserted at the upper and lower margins of the remaining nodes (C) (dotted arrows).

coming to operation. In 80 patients, lymph-node metastases were present.

2. Study of the anatomy of the lymof lymph-node metastases; nor between metastases and the preoperative estimated length of the primary tumor. A

high histologic grade of malignancy is associated with a slightly higher incidence of lymph-node metastases.

4. (A) When the primary lesion involves the midthoracic esophagus, there may be a slightly greater tendency for the disease to spread to the right than to the left paratracheal nodes.

(B) When the tumor is situated in the third or fourth segment of the esophagus, there is a high incidence of involvement of the para-esophageal chain of lymph nodes.

(C) The lower the level of the primary tumor in the esophagus, the more likely it is that there also will be lymph-node metastases beneath the diaphragm.

5. Radiographic identification of intrathoracic and subdiaphragmatic lymph nodes enlarged by metastases from esophageal carcinoma is possible in many instances. By this means, the extent of the disease can be more accurately determined. Successful treatment is dependent on the eradication of both the primary tumor and the lymph-node metastases.

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SUMARIO

Identificación Radiográfica de las Metástasis del Carcinoma Esofágico en los Ganglios Linfáticos

Básase esta communicación en 119 casos seleccionados de carcinoma del esófago que fueron operados, y en 80 de los cuales había metástasis linfadénicas.

El estudio de la anatomía del sistema de riego linfático del esófago pone de manifiesto que émbolos cancerosos pueden ser transportados por los vasos linfáticos a la cadena más próxima de ganglios linfáticos o depositados a cierta distancia del tumor primario. La causa de esto es que los vasos colectores, que están presentes en la submucosa y en la túnica muscular del esófago, se extienden por todo el largo de éste, y no sólo se entrecomunican sino que se comunican con vasos aferentes de los ganglios linfáticos regionales a niveles sucesivos del esófago.

En el grupo estudiado, no se descubrió ninguna relación entre la duración declarada de los síntomas y la presencia o ausencia de metástasis linfadénicas; ni tampoco entre las metástasis y la longitud calculada preoperatoria del tumor primario. Un grado alto de malignidad histológica se enlaza con una incidencia ligeramente más alta de metástasis.

Cuando la lesión primaria afecta el esófago mesotorácico, quizás haya una tendencia un poco mayor de parte de la dolencia a difundirse a los ganglios paratraqueales del lado derecho más bien que del izquierdo. Cuando el tumor está situado en el tercero o el cuarto segmento del esófago, es alta la incidencia de invasión de la cadena paraesofágica de ganglios linfáticos. Mientras más bajo es el nivel del tumor primario en el esófago, más probable es que también haya metástasis linfadénicas debajo del diafragma.

En muchos casos, resulta posible la identificación de los ganglios linfáticos intratorácicos y subdiafragmáticos hipertrofiados por metástasis del carcinoma esofágico. De ese modo cabe determinar con mayor exactitud la difusión de la enfermedad. El éxito del tratamiento depende de la erradicación del tumor primario y de las metástasis en los ganglios linfáticos.

The Normal Cervical Spine in Infants and Children[1]

DONALD K. BAILEY, M.D.[2]

NUMEROUS PAPERS on the subject of roentgenology of the cervical spine, especially with reference to the roentgen anatomy, have been published. Most of these deal exclusively with adults. The material presented here, although not new, represents an attempt to bring together data concerning the cervical spine in infants and children. In this age group, the developmental anatomy of the cervical spine must be correlated with the roentgen appearance. Because the appreciation and appraisal of roentgen abnormalities depend so much on a thorough understanding of the normal, the normal will be discussed and only a few pertinent anomalies will be mentioned. The present study is based in part on roentgenograms of the cervical spine in approximately 100 normal children ranging from the newborn infant to the age of fourteen years. None of these children had a known history of trauma.

The technics employed to obtain satisfactory films of the cervical spine are not pertinent to the discussion, but certain difficulties arise in the examination of children which are not encountered in adults. These are attributable to lack of cooperation and the immature state of muscular development in infants. It is often impossible to obtain upright films, laminagrams, and stereoscopic examinations. Sedation is frequently necessary to obtain even routine recumbent films. As a result, not all of the modalities used in studying adults are available for children. The normal appearance in the few standard projections must therefore be stressed.

The anatomical details are best demonstrated by means of reproductions of drawings and roentgenograms. The illustrations are of three types: (1) those which show the developmental anatomy of the cervical vertebrae (Figs. 1–3); (2) representative roentgenograms of the normal cervical spines of infants and children (Figs. 4–15); (3) a diagram for orientation in oblique spine projections (Fig. 16). No roentgenograms of children over eight years of age are included because, with few exceptions, the cervical spine has attained an adult form by this age.

First Cervical Vertebra (Atlas): Among other features, cervical vertebrae differ from the dorsal and lumbar vertebrae in that they have a foramen in each transverse process. The first and second cervical vertebrae also differ from the other cervical vertebrae because of certain distinguishing characteristics.

The first cervical vertebra is normally formed from three primary ossification centers, one for each neural arch and one for the body. There are three principal variations in development. (1) The bodies may arise from two centers, which ultimately fuse with each other and with the neural arches. (2) Occasionally an ossification center for the body fails to appear and in its place there are forward extension and fusion of the anterior portions of each neural arch. (3) The center for the body may be absent and the lateral masses fail to fuse anteriorly, resulting in a cleft.

The center for the body is normally not ossified at birth but becomes visible roentgenographically during the first year of life. The two neurocentral synchondroses (Fig. 1) fuse at about the seventh year, and before this age the line of ultimate fusion should not be mistaken for a fracture. The ligament surrounding the superior vertebral notch (Fig. 1) is usually not ossified in children and, therefore, presents no par-

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ticular problem, as it may in adults. Figure 4 demonstrates the normal atlanto-occipital articulation at two and a half years of age. Figures 14A and B illustrate the cervical spine of a child before and after ossification of the primary center for the body of the atlas.

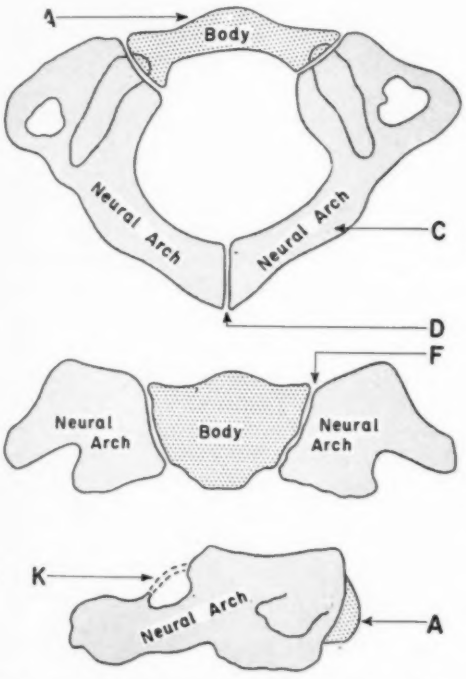


Fig. 1. Diagram of first cervical vertebra (atlas).
A. Body: Not ossified at birth; center (occasionally two centers) appears during first year after birth; body may fail to develop and forward extension of neural arches may take its place.
C. Neural arches: Appear bilaterally about seventh fetal week; most anterior portion of superior articulating surface is usually formed by the body.
D. Synchondrosis of spinous processes: Unite by third year. Union may rarely be preceded by the appearance of a secondary center within the synchondrosis.
F. Neurocentral synchondrosis: Fuses about the seventh year.
K. Ligament surrounding the superior vertebral notch: May ossify, especially in later life.

Second Cervical Vertebra (Axis, Epistropheus): It is in the region of the second cervical vertebra that the most complex difficulties arise in differentiating normal developmental anatomy from abnormal change. There are four primary ossification centers in the axis, all of which are present at birth: one center for the odontoid, one for the body, and two for the neural arches. Prior to the fusion of these centers, between the ages of three and six years, any of the synchondroses may be mistaken for a fracture. This is particularly true of the synchondrosis between the odontoid and the body (Figs. 2, 4, 9 and 14A), when viewed in the lateral projec-

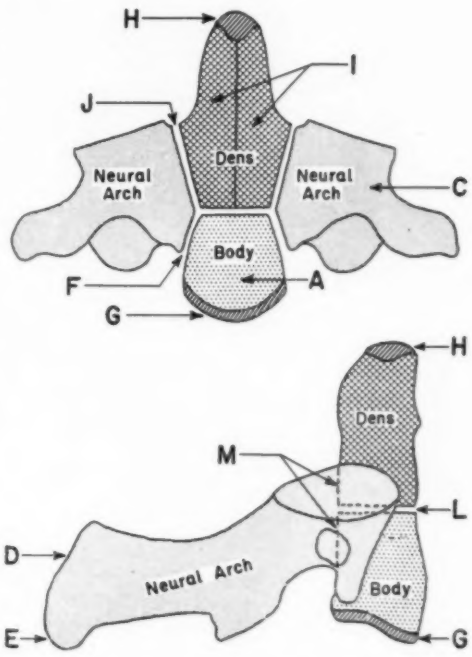


Fig. 2. Diagram of second cervical vertebra (axis or epistropheus).
A. Body: One center (occasionally two) appears by the fifth fetal month.
C. Neural arches: Appear bilaterally by the seventh fetal month.
D. Neural arches fuse posteriorly by second or third years.
E. Bifid tip of spinous process (occasionally a secondary center is present in each tip).
F. Neurocentral synchondrosis: Fuses at three to six years.
G. Inferior epiphyseal ring: Appears at puberty and fuses at about twenty-five years.
H. "Summit" ossification center for odontoid: Appears at three to six years and fuses with odontoid by twelve years.
I. Odontoid (dens): Two separate centers appear by the fifth fetal month and fuse with each other by seventh fetal month.
J. Synchondrosis between odontoid and neural arch: Fuses at three to six years.
L. Synchondrosis between odontoid and body: Fuses at three to six years.
M. Posterior surface of body and odontoid.

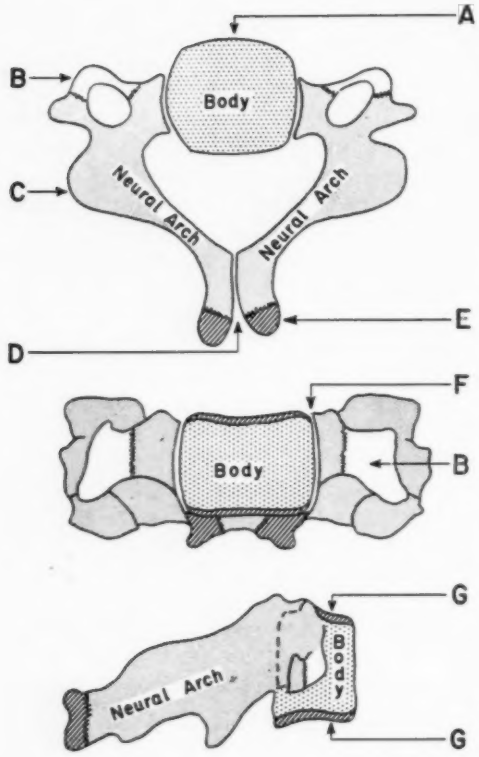


Fig. 3. Diagram of typical cervical vertebrae C-3 to C-7.

A. Body: Appears by fifth fetal month.
B. Anterior (costal) portion of transverse process: May develop from a separate center which appears by sixth fetal month and joins the arch by the sixth year.
C. Neural arches: Appear by seventh to ninth fetal week.
D. Synchondrosis between spinous processes: Usually unites by second or third year.
E. Secondary centers for bifid spine: Appear at puberty and unite with spinous process at twenty-five years.
F. Neurocentral synchondrosis: Fuses at three to six years.
G. Superior and inferior epiphyseal rings: Appear at puberty and unite with body at about twenty-five years. The seventh cervical vertebra differs slightly because of a long powerful non-bifid spinous process.

tion. The secondary ossification center at the summit of the dens (Figs. 2 and 6) normally appears between three and six years and fuses with the dens by the age of twelve years.

Figures 2 and 5 are presented to correlate the roentgen anatomy of the second cervical vertebra with its developmental features. Figure 6 demonstrates an interesting normal variant in which the dens has arisen from two separate centers which have not fused at the midline; fusion between the dens and the body has also failed to occur. Figure 8 shows the upper cervical vertebra as seen on the occipital view of the skull. As shown in this projection, the posterior portions of the neural arches of the upper cervical vertebrae are unfused and remain so until about the age of three.

"Typical" Cervical Vertebrae (C-3–C-7): The remaining cervical vertebrae closely resemble each other except that the 7th has a long, powerful, non-bifid spinous process. The vertebral artery and vein pass in front of its transverse process rather than through its foramen, as in the other cervical vertebrae. The anterior portion of the transverse process of the 7th cervical vertebra may persist as a separate process and become elongated to form a cervical rib (Fig. 15). In the lateral projection, the typical cervical bodies appeared wedge-shaped, being narrower anteriorly (Figs. 9, 11, 14A and B). The amount of wedging decreases with age. Since the laryngeal cartilages are usually not calcified in children, these structures do not interfere with visualization of the spine in the anteroposterior and oblique projections.

OBLIQUE VIEWS OF THE CERVICAL SPINE

Optimal visualization of pedicles, laminae, and intervertebral foramina is achieved by oblique views of the cervical spine. However, in the attempt to visualize these components, structures and landmarks with respect to right or left may be confusing. In children the presence of unfused ossification centers tends to add to the confusion. Figure 16 is included to demonstrate which pedicles, laminae, and intervertebral foramina are optimally projected in each oblique position. In the left posterior oblique projection, for example, the x-ray beam is traversing the long axes of the left pedicle, the right intervertebral foramen, and the right lamina. As a result, the left pedicle and right lamina are seen "end-on," while the right intervertebral foramen is "opened

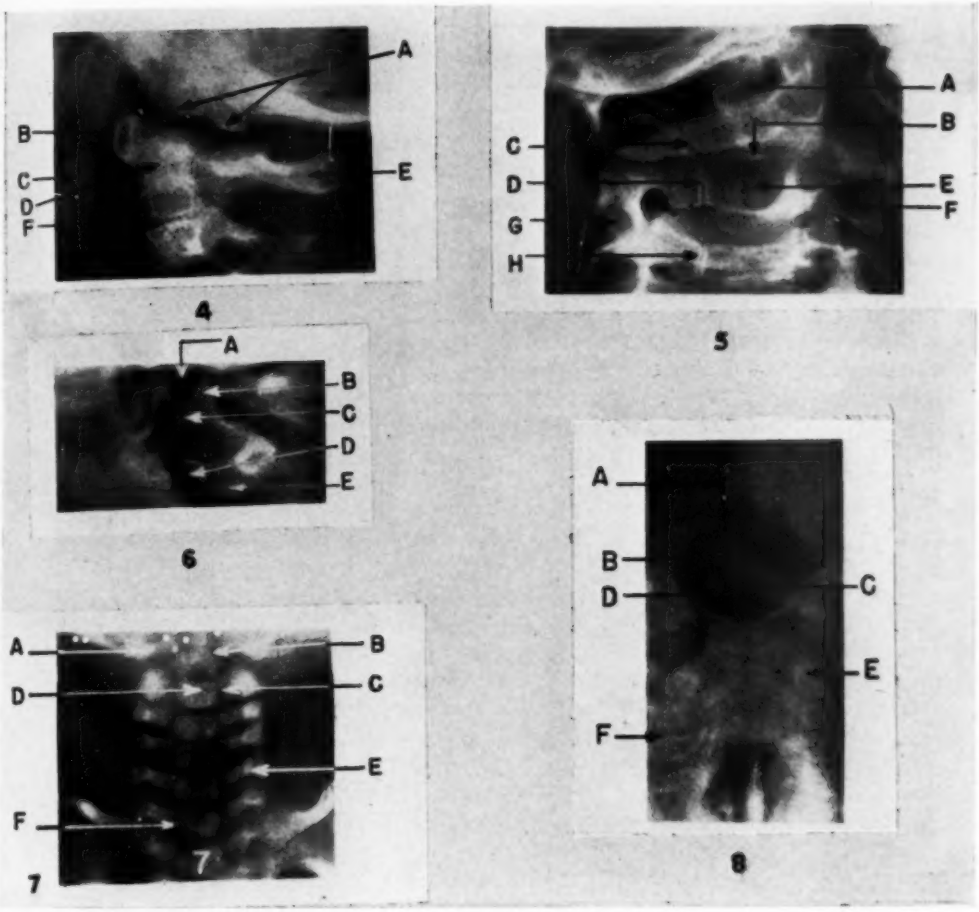


Fig. 4. Male, 2 1/2 years: lateral view of upper cervical spine. A. Condyles of occiput for articulation with superior articulating surfaces of atlas. B. Body of atlas. C. Ramus of mandible. D. Odontoid process of axis. E. Posterior portion of neural arch. F. Synchondrosis between body and odontoid of axis.

Fig. 5. Five-year-old male: anteroposterior view of upper cervical area with head slightly turned. A. Odontoid process. B. Synchondrosis between odontoid and body of axis. C. Synchondrosis between odontoid and neural arch of axis. D. Neurocentral synchondrosis (between body and neural arch of axis). E. Body of axis. F. Transverse foramen of axis. G. Inferior articulating surface of axis. H. Neurocentral synchondrosis of third cervical vertebra.

Fig. 6. Three-year-old male: open-mouth view of second cervical vertebra (anomalous development). A. "Summit" ossification center of odontoid. B. Lateral center of odontoid which has failed to fuse with its partner. C. Synchondrosis dividing unfused portions of odontoid. D. Body of axis. E. Neurocentral synchondrosis of axis.

Fig. 7. One-month-old female: anteroposterior projection of entire cervical spine. A. Neural arch of atlas. B. Odontoid process of axis. C. Neurocentral synchondrosis of axis. D. Body of axis. E. Neural arch of fifth cervical vertebra. F. Neurocentral synchondrosis of sixth cervical vertebra.

Fig. 8. Eleven-month-old female: occipital projection of the skull. A. Metopic suture of frontal bone. B. Foramen magnum. C. Synchondrosis between unfused spinous processes of atlas. D. Posterior portion of neural arch of atlas. E. Neural arch of axis. F. Articulation between C-3 and C-4.

up." Many prefer to reverse the tube-film relationship noted in Figure 16. At a distance of 6 feet, the altered position is probably of no significance, but with shorter distances the reverse relationship may be preferred to bring the "open" intervertebral foramen closer to the film. Figures 12 and 13 show the actual relation-

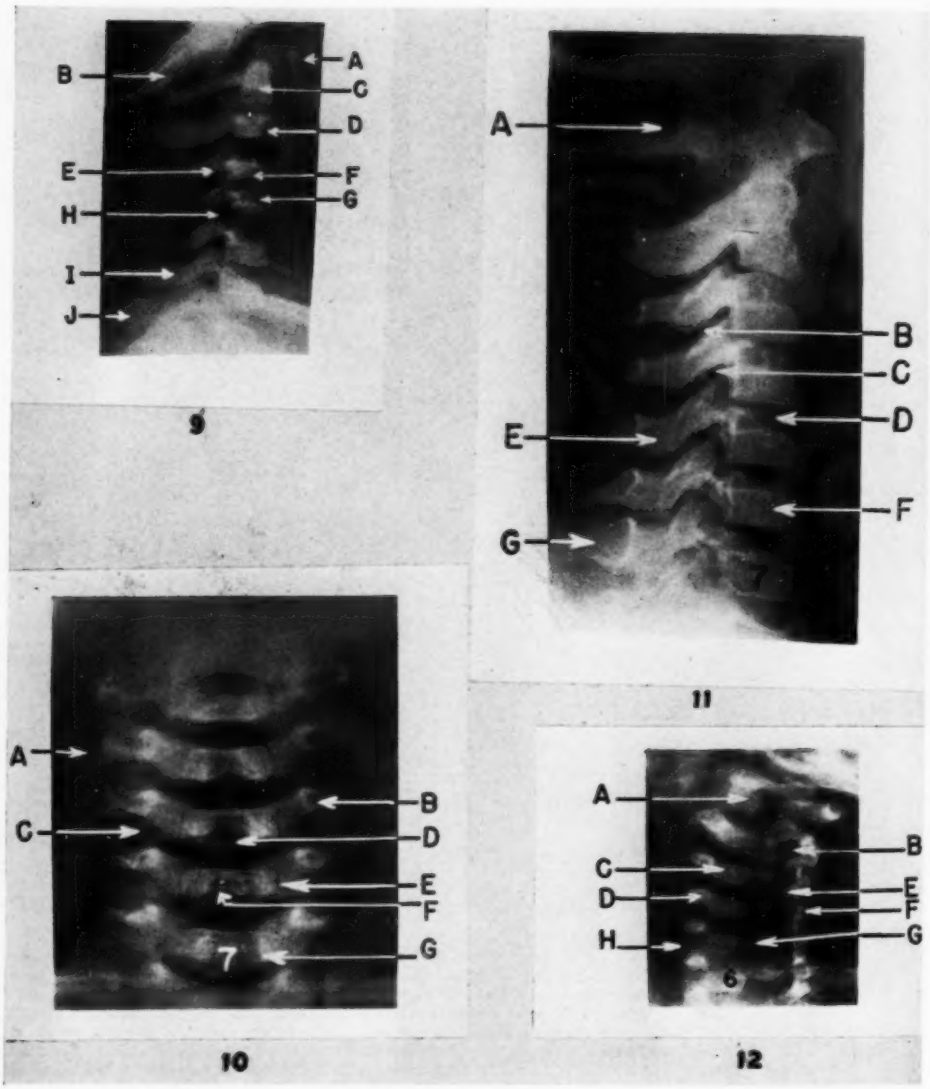


Fig. 9. Five-month-old female: lateral view of cervical spine. A. Body of atlas. B. Portion of occipital bone. C. Odontoid. D. Body of axis. E. Articular "pillar" of C-3. F. Body of C-3. G. Transverse process of C-4. H. Articulation between C-4 and C-5. I. Lamina of C-6. J. Spinous process of C-7.

Fig. 10. Male, 2 1/2 years: anteroposterior projection of cervical spine. A. Right transverse process of C-4. B. Left pedicle of C-5 (pedicles normally poorly seen in anteroposterior view). C. Articulation between C-5 and C-6. D. Body of C-5. E. Neurocentral synchondrosis of C-6. F. Spinous process of C-6. G. Superimposed air column of trachea.

Fig. 11. Five-year-old female: lateral view of cervical spine. A. Groove in atlas for vertebral artery and first cervical nerve. B. Superior articular surface of C-4. C. Inferior articular surface of C-4. D. Transverse process of C-5. E. Lamina of C-5. F. Body of C-6. G. Spinous process of C-7.

Fig. 12. Two-month-old female: right posterior oblique projection of cervical spine. A. Odontoid. B. Left intervertebral foramen between C-2 and C-3. C. Body of C-3. D. Right pedicle of C-4 "end-on." E. Left pedicle of C-4. F. Left lamina of C-5 seen "end-on." G. Neurocentral synchondrosis of C-5. H. Right transverse process of C-6. Compare with Fig. 13.

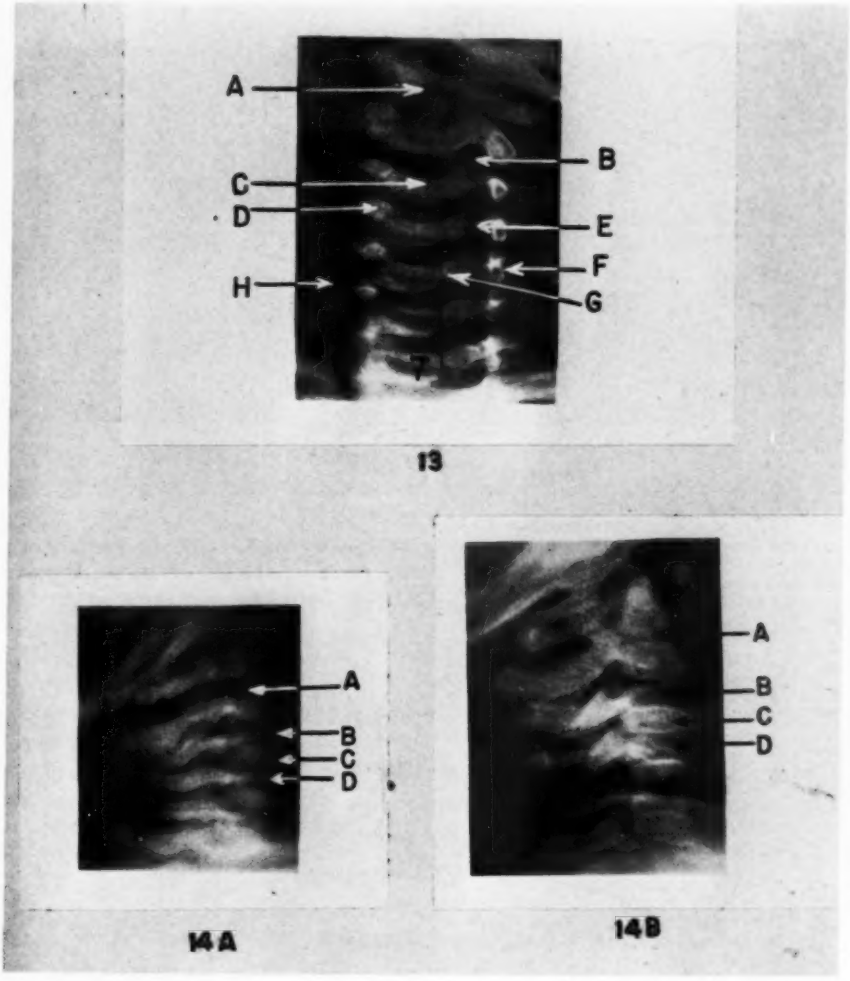


Fig. 13. Six-month-old female: right posterior oblique projection of cervical spine. A. Odontoid. B. Left intervertebral foramen between C-2 and C-3. C. Body of C-3. D. Right pedicle of C-4 "end-on." E. Left pedicle of C-4. F. Left lamina of C-5 seen "end-on." G. Neurocentral synchondrosis of C-5. H. Right transverse process of C-6. Compare with Fig. 12.

Fig. 14. Two films of same male at five weeks (A) and at age of two years (B). A. Synchondrosis between odontoid and body of axis. B. Transverse process of C-3. C. Body of C-3. D. Transverse process of C-4. Note that the transverse processes projected on the intervertebral spaces resemble compressed vertebral bodies at five weeks, but at two years are easily identified as transverse processes. Also note the ossification of the body of the atlas in Fig. 14B not present in Fig. 14A.

ship of the various structures as seen in the oblique view.

In both children and adults, the superimposition of a transverse process on one of the intervertebral spaces may cause some error in interpretation. Figure 14A is an example of a lateral projection of the neck in a child five weeks of age. The transverse processes are superimposed on the intervertebral spaces and compression fracture of the vertebral bodies is simulated. The cervical spine of the same child at the age of two years is shown in Fig. 14B. The transverse processes are still superimposed on the intervertebral spaces, but are readily identified.

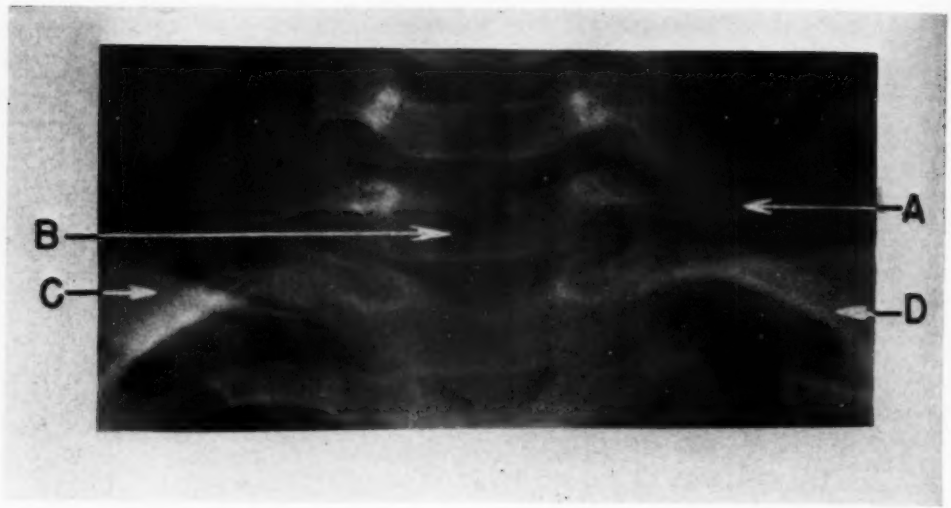
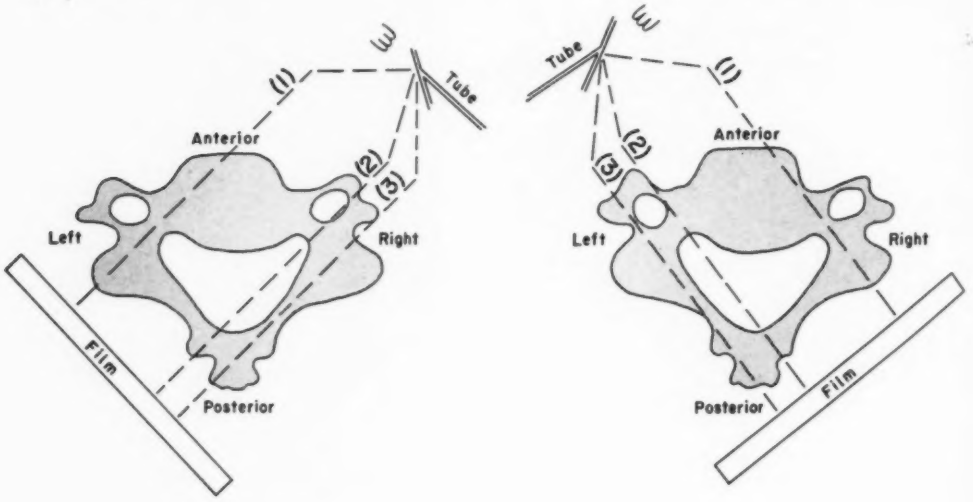


Fig. 15. Male, 8 years: anteroposterior projection of cervicodorsal area. A. Slightly elongated ununited anterior (costal) process of transverse process of C-7. B. Body of C-7. C. Right clavicle. D. Left first rib.



LEFT POSTERIOR OBLIQUE RIGHT POSTERIOR OBLIQUE

Fig. 16. Oblique projection of cervical spine with respect to optimum visualization of pedicles, laminae, and intervertebral foramina.

Left posterior oblique: Beam traversing (1) long axis of left pedicle, (2) right intervertebral foramen, and (3) right lamina. Note that the left pedicle is seen "end-on," right intervertebral foramen is "opened up," and right lamina is seen "end-on."

Right posterior oblique: Beam traversing (1) long axis of right pedicle, (2) left intervertebral foramen, and (3) left lamina. Note that right pedicle is seen "end-on," left intervertebral foramen is "opened up," and left lamina is seen "end-on."

Due to immature musculature in very young infants, a reversal of the normal smooth anterior curve is occasionally observed in the lateral projection of the cervical spine. In lateral roentgenograms of the cervical spine in adults, with the neck

held in mild flexion, some "step-off" is normally seen, *i.e.*, the body of each vertebra is displaced slightly anteriorly with respect to the subjacent one. Infants and children show the same normal finding when the neck is held in mild flexion, especially at the level of the second and third cervical vertebrae, where there may be a step-off of as much as 2 to 3 mm.

In adults, the upper cervical intervertebral foramina are ovoid while the lower ones tend to be shaped like the sole of a shoe (Hadley). In children, all of the intervertebral foramina, as seen in the oblique projection, tend to be ovoid (Figs. 12 and 13).

At the onset of this study, it was thought that measurements of portions of the cervical spine in normal children at various age levels might be of some importance, as, for example, average distance from the anterior portion of the odontoid to the posterior surface of the body of the atlas and intervertebral widths at various levels and in various age groups. It soon became evident that careful attention to symmetry and normal anatomical development was far more informative and practical than actual measurements.

SUMMARY

The developmental anatomy of the cervical spine in infants and children has been correlated with the roentgen anatomy. The aim has been to bring together readily available, separately published observations so that problems concerning the cervical spine of this age group may be more readily resolved.

ACKNOWLEDGMENTS: Thanks are due Mr. Joseph Homan, Professor of Medical Art, and his staff, especially Miss Jean Schuff, for the drawings and photographs. Cervical vertebrae were kindly lent through the courtesy of Dr. James Wilson, Department of Anatomy. Thanks for reviewing the manuscript are due Dr. Frederic N. Silverman, Director, Department of Roentgenology, Children's Hospital, and to Dr. Ben Felson, Professor of Radiology. All are members of the staff of the University of Cincinnati College of Medicine.

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SUMARIO

Lo Normal en la Porción Cervical del Raquis en los Lactantes y Niños

Al estudiar radiográficamente la porción cervical del raquis en los lactantes y los niños mayores, hay que correlacionar las observaciones roentgenológicas con las alteraciones creadas por el desarrollo normal. Por ejemplo, no hay que confundir sincondrosis aun no consolidadas con fracturas, y deben tenerse presentes las variaciones normales.

Los pormenores anatómicos quedan expuestos en tres grupos de grabados: (1) los que muestran la anatomía evolucionaria de las vértebras cervicales (Figs. 1–3); (2) típicas radiografías de la porción cervical del raquis normal en criaturas y niños; (3) diagrama para orientar las proyecciones oblicuas del raquis (Fig. 16). No se ofrecen radiografías de niños de más ocho años, porque, con pocas excepciones, la porción cervical de la espina dorsal ha alcanzado ya su forma adulta para dicha edad.

Therapeutic Effects in Hyperthyroidism from Repeated Diagnostic Doses of I^{131}[1]

SIDNEY C. WERNER, M.D., HOWARD B. HAMILTON, M.D., and MARTHA R. NEMETH
New York, N. Y.

SEVERAL REPEATED tracer doses of I^{131} are commonly used to follow the course of hyperthyroidism under treatment of various types. While it is generally assumed that these tracer amounts of the isotope are innocuous, evidence from three directions has suggested the need to test this assumption.

The first observation in this clinic in conflict with the commonly accepted concept has been the consistent reporting by occasional patients with toxic goiter that they "felt better" following a diagnostic tracer test. The obvious explanation has been the facile one, that a factor of suggestion is involved. This has not always appeared adequate.

The second cause for suspicion of a possible effect from tracer dosage is the finding that there is a wide biological variability in response to therapeutic doses of I^{131} in hyperthyroidism (1). Extreme sensitivity of the thyroid to internal radiation effect has been noted, as well as extreme resistance. As a consequence, it has appeared reasonable that smaller dosages of I^{131} than those used therapeutically might have some effect. This lower dosage range has remained unexplored since the failure of Soley and Miller to achieve remissions with doses of 250 microcuries repeated several times (2).

Finally, interest in a possible effect from tracer dosage has been aroused by the conflict in results between groups investigating the effect of ACTH upon hyperthyroidism (3, 4, 5). The only apparent difference in procedure has been the number of tracer tests and the size of the dose of I^{131} used in each test.

For these reasons, then, the present investigation was undertaken to determine the effect upon hyperthyroidism of several tracer doses of I^{131}. It has been found that complete remission of thyrotoxicosis may result from as little as 240 microcuries I^{131}, total dosage. The time interval from the beginning of the experiment to the achievement of remission has, in most instances, paralleled that of therapeutic doses of I^{131}. The remissions following smaller dosage generally have been transient.

METHODS

The methods employed by this laboratory for tracer testing with I^{131} and for direct measurement over the thyroid of uptake of the isotope at twenty-four hours have been described in detail elsewhere (6). In all cases the diagnosis was made and the patient was followed from the clinical and laboratory standpoints as previously detailed (7). Only patients with unquestioned hyperthyroidism due to toxic diffuse or toxic recurrent goiter were used in the present study. It should be pointed out that the series includes several children. These were deliberately treated after an initial observation indicated the possibility, in this age group, of unusual susceptibility of the thyroid to radiation effect. Basal metabolic rate determinations were conducted with the use of a Benedict Roth apparatus. Serum precipitable iodine was estimated by the method of Barker (8).

Two plans of tracer dosage were employed. With one, a single dose of 40 microcuries of I^{131} was given by mouth at weekly intervals for from four to seven weeks. Uptake by the gland was determined for each dose twenty-four hours after administration. The status of the patient

[1] From the Department of Medicine, College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital in the City of New York. This work has been aided by a grant from the National Institutes of Health, U. S. Public Health Service. Presented at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

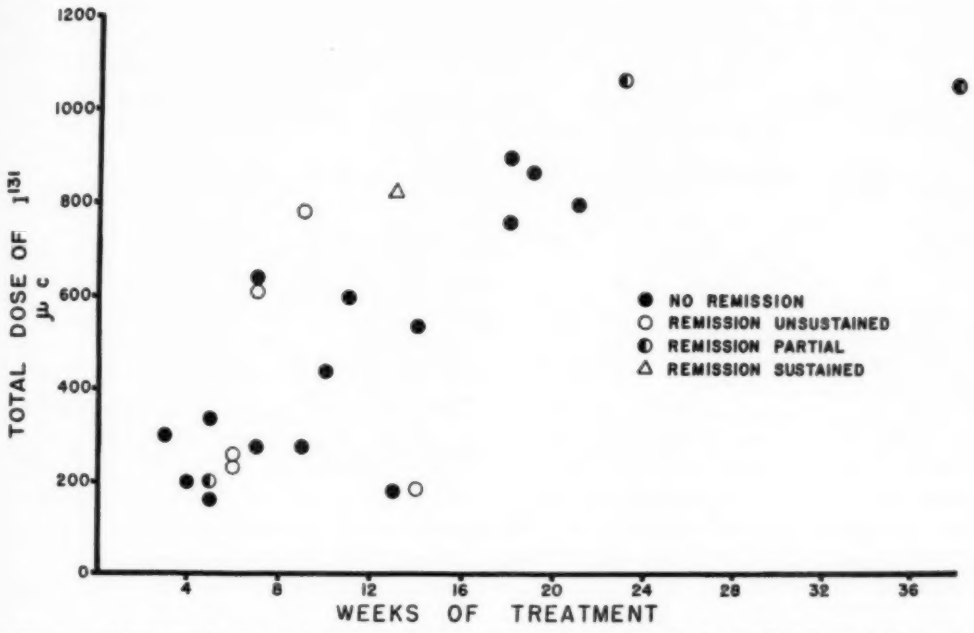


Fig. 1. Total dosage from repeated tracer doses of I^{131} and therapeutic effect. Radioiodine uptake by the thyroid at twenty-four hours in 2 patients entering remission and depicted as receiving 800 to 900 microcuries fell abruptly after administration of 400 and 500 microcuries.

was evaluated two weeks after the last dose and, subsequently, every two to four weeks. In most instances, blood for serum iodine determinations was taken during the period of I^{131} administration, as well as before and after. In half the patients a similar course of dosage was administered following recurrence of toxicity or when only partial remission resulted from the initial series. With the second plan, larger doses of I^{131}, 100 or 200 microcuries, were administered weekly for three doses. Effects were followed as with the smaller dosage group. The larger dosage course was repeated, if indicated, once or several times, after an observation period of several weeks.

RESULTS

The series studied consists of 24 patients: 2 men, 20 women, and 2 children of twelve years.

The effects of repeated tracer dosage have been classified under three headings: (1) "complete remission," that is, the achievement of euthyroidism as judged by clinical appraisal and laboratory status; (2) "partial remission," where definite clinical and laboratory improvement has been found but with evident residual thyrotoxicosis; (3) "failure," where no clinical improvement has been apparent, regardless of improvement in laboratory values noted in many instances.

Complete Remission: In 6 patients the response to repeated tracer doses of I^{131} may be classified as "complete remission" (Figs. 1–4). The total dosage in these cases ranged from 240 to 940 microcuries. It should be pointed out that uptake of I^{131} was drastically decreased by the time of administration of 500 microcuries in the 2 patients receiving a total dosage of more than 600 microcuries, even though weekly dosage was continued (Figs. 2 and 3). Three patients received as little as 240 to 280 microcuries. The radiation effect provided to the group entering remission is estimated at between 161 rep and 780 rep (Table I), with the upper figure even lower

TABLE I: AMOUNT OF RADIATION RECEIVED BY THE THYROID GLANDS OF PATIENTS ENTERING COMPLETE REMISSION OF HYPERTHYROIDISM AFTER REPEATED TRACER DOSES OF I^{131}

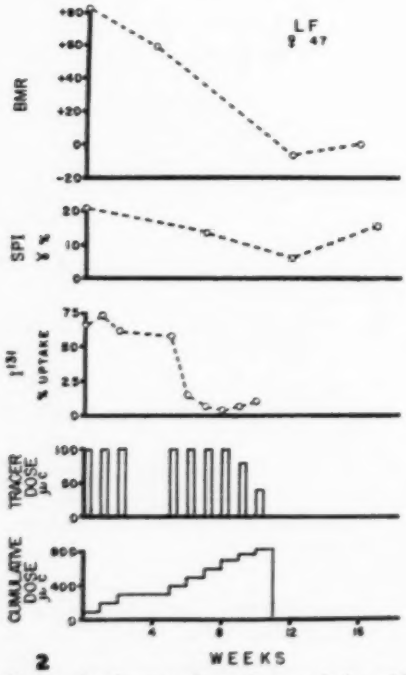
Patient	I^{131} Dosage Schedule (μc)	Total I^{131} Dosage Given (μc)	Radiation Received from Single Dose I^{131} (rep)	Radiation Received from Total I^{131} Dosage (rep)
S. C.	40 × 6	240	100	607
D. P.	40 × 6	240	27	161
	40 × 7*	280	29	202
R. A.	40 × 6	260	41	266
H. C.	100 × 3	300	62	187
	100 × 3†	300	77	231
L. F.	100 × 3	300	37	110
	100 × 5†	480	37	185
R. S.	100 × 5	500	82	410
	100 × 4‡	440	79	324

* Six months between series. † Three weeks between series. ‡ Three months between series.

if radiation is calculated from the dosage at which I^{131} uptake became sharply reduced. The radiation provided by each single dose of I^{131} is estimated at between 30 and 100 rep in round figures. The size of the thyroid gland was not appreciably altered in any instance.

In only 1 of the 6 patients achieving euthyroidism was this status sustained for more than two or three months (Fig. 4). Again, no apparent alteration in gland size accompanied resumption of thyrotoxicity. In 1 instance the initial course of 240 microcuries of I^{131}, resulting in remission, was repeated following return of toxicity. A second successful but again unsustained outcome resulted.

In the other 3 patients in the group re-



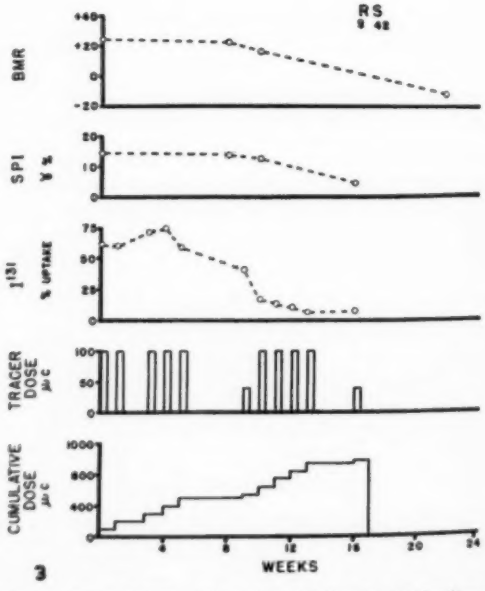
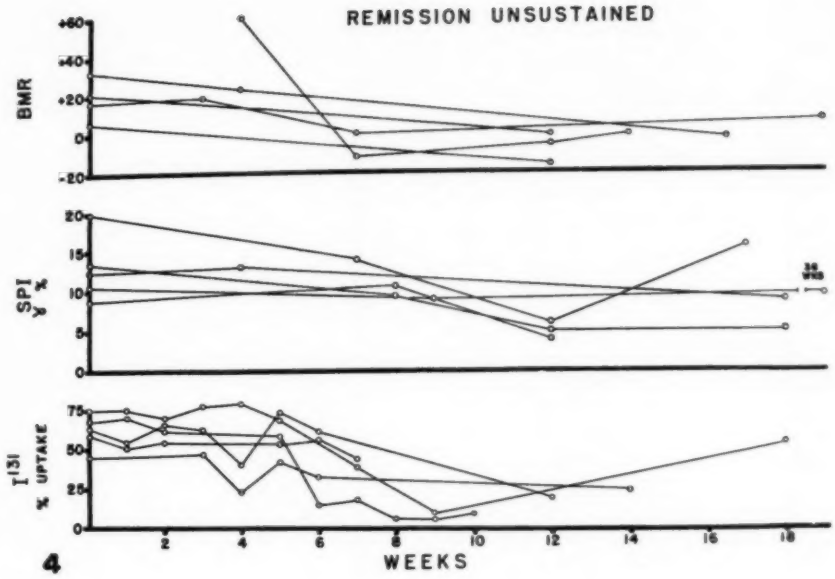


Fig. 2. Attainment of complete remission with repeated tracer doses of I^{131}. Note abrupt fall, after 400 microcuries I^{131}, in uptake of isotope at twenty-four hours.

Fig. 3. Fall after administration of 500 microcuries of I^{131} in uptake of isotope at twenty-four hours in patient achieving complete remission.



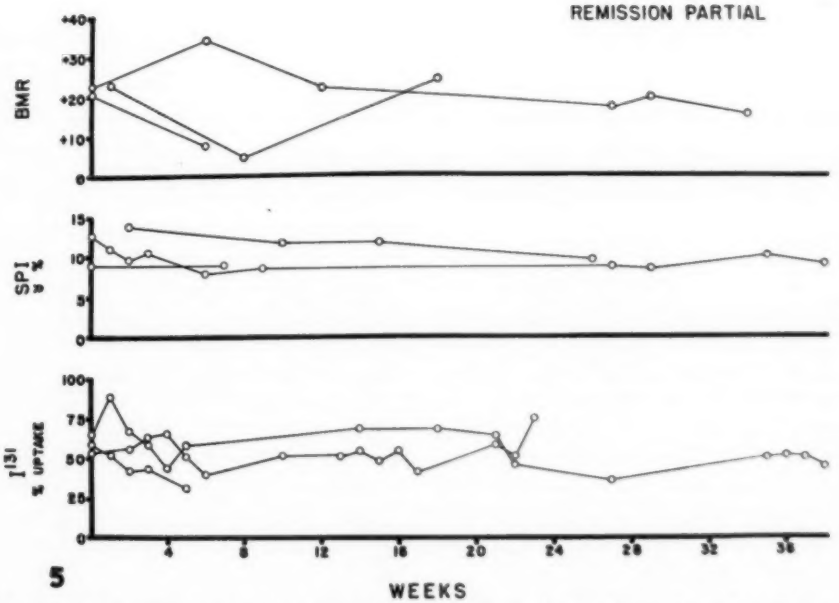


Fig. 4. Laboratory values in 5 patients entering complete remission of hyperthyroidism after repeated tracer doses of I^{131}. The results in a sixth patient remaining euthyroid are not depicted.
Fig. 5. Laboratory values in 3 patients experiencing considerable amelioration of hyperthyroidism after several repeated tracer doses of I^{131} but failing to achieve euthyroidism.

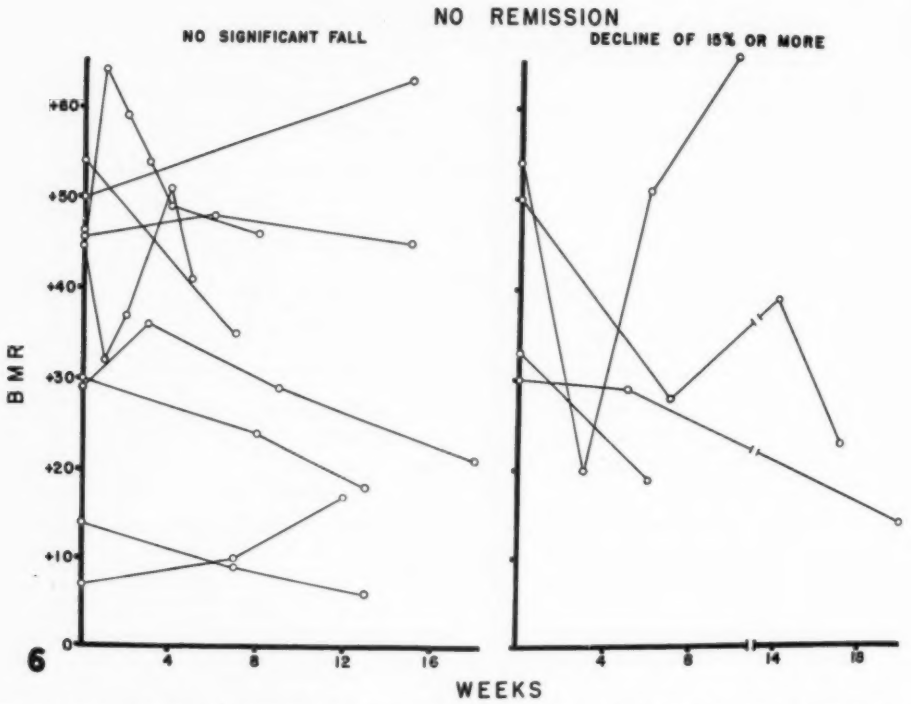


Fig. 6. Changes in basal metabolic rate in patients with hyperthyroidism failing to respond otherwise to repeated tracer doses of I^{131}.

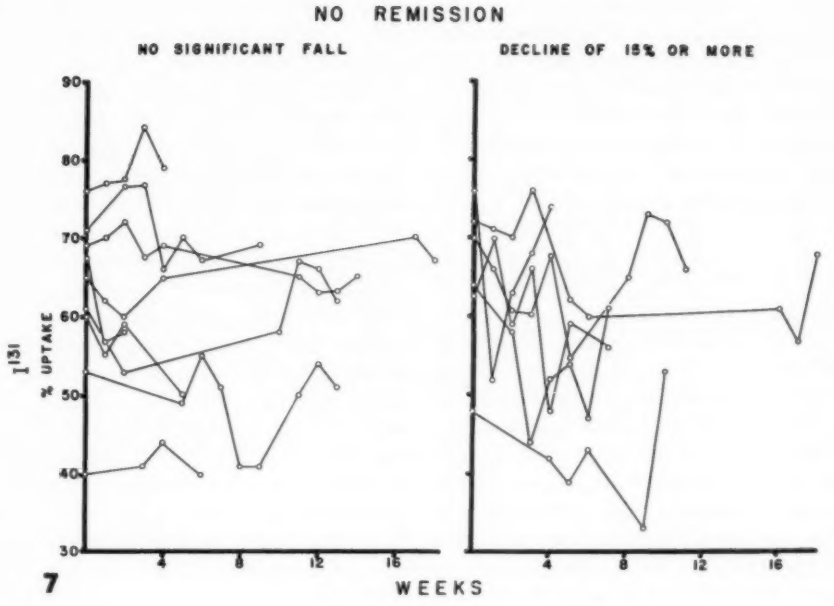
ceiving several series of tracer doses, indicated by the higher total dosages, only partial subsidence of hyperthyroidism, or none at all, resulted from the initial series of doses.

Partial Remission: In 3 patients partial remission was obtained (Figs. 1 and 5). The total dosage of I^{131} in this group varied from 200 to 1,080 microcuries. Gland size remained unaffected in all. In the 2 observed for longer periods, recurrence of the previous level of thyrotoxicosis was noted. The other was treated definitively and was not observed long enough for appraisal from this standpoint.

Failure: In 15 patients no clinical improvement was observed (Fig. 1). The total dosage received by these patients ranged from 160 to 900 microcuries. The striking finding in this group is the extent of independent fluctuation noted in the several laboratory tests following repeated tracer dosage (Figs. 6–8). Thus, a fall in basal metabolic rate may take place without corresponding change in tracer uptake or serum precipitable iodine level. Similarly, the values for either of the latter may decrease appreciably without corresponding decline in the other values.

The basal metabolic rate was noted to decrease 15 per cent or more in 4 instances, despite lack of definite clinical change (Fig. 6). The percentage uptake of I^{131} by the thyroid at twenty-four hours declined 15 per cent or more in 6 cases (Fig. 7). The level of serum precipitable iodine was seen to decrease 2.5 gamma per cent or more in 3 instances (Fig. 8). In general, the changes in laboratory values were transient, with rapid return to previous levels.

Children: The two children studied received a total of 240 and 260 microcuries of I^{131}, estimated to have provided 161 and 266 rep, respectively. Recurrence of toxicity after several months was noted in both patients. A second course of 280 microcuries



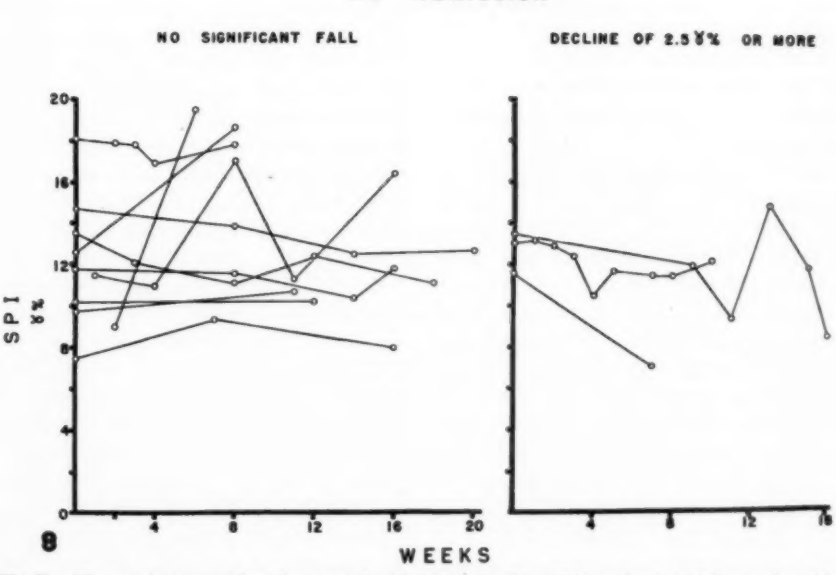


Fig. 7. Changes in twenty-four-hour uptake of I^{131} by the thyroid in patients with hyperthyroidism failing to respond otherwise to repeated tracer doses of I^{131}.

Fig. 8. Changes in levels of precipitable iodine in patients with hyperthyroidism failing to respond otherwise to repeated tracer doses of I^{131}.

given to the first child resulted in a second complete remission, with subsequent recurrence, in the same time sequence as with the earlier series. Since this analysis, 4 more children have been treated with 240 microcuries of I^{131} in divided dosage, with a successful outcome in 2. In both of the latter this remission has been maintained for four months.

DISCUSSION AND CONCLUSIONS

The findings in this experiment demonstrate that the cumulative effect of several repeated 40- to 100-microcurie tracer doses of I^{131} may induce changes in thyroid function in a significant percentage of hyperthyroid patients. Such tracers cannot be said to be physiologically without effect. This result must be taken into consideration in reviewing the conclusions from previous and current studies of various agents or procedures thought to influence the course of hyperthyroidism. The several remissions from hyperthyroidism attributed to ACTH or cortisone by the Boston group (3, 4) and not obtained in this clinic (5), for example, can as well be explained by the more frequent tracer testing and larger doses of I^{131} used by the former, as by a true physiological effect from corticotrophin or steroid.

The total radiation provided by the tracer doses of I^{131} given in the present investigation (161 to 780 rep), resulting in remission, is considerably under the 4,000 to 6,000 rep believed to be the minimum necessary for the successful treatment of hyperthyroidism. Rather it approaches the level of radiation provided by x-ray therapy for toxic goiter. The tendency to recurrence after these smaller dosages of I^{131} is also similar to that frequently seen following x-ray therapy. It is indicated that the present lower limits of I^{131} dosage can be reduced in selected cases. A method is needed to distinguish these radiosensitive patients from the great majority with more radioresistant glands.

Children with hyperthyroidism appear from this study to be frequently susceptible to low levels of radiation effect from I^{131}. Fear of later radiation-induced cancer of the thyroid serves at present to prevent the development of the use of I^{131} therapeutically in this age group, even with the smaller doses. The observation calls attention, however, to the possibility of successful therapy from external radiation with x-rays. The need for safeguarding other neck structures such as the epiphyses of the cervical vertebrae is evident, but no other immediate contraindication to such an investigation is apparent.

The present results emphasize the desirability of decreasing tracer doses of I^{131} in diagnostic studies, as soon as possible, by the use of more sensitive gamma-ray-detection devices, such as the bismuth and scintillation counters. A single 40 to 100 microcurie dose of I^{131} in tracer testing of euthyroid individuals probably results in no demonstrable injury to the gland. Nonetheless, with increasing use of tracer methods, the chance that the test may be repeated in a second or third clinic is becoming greater. It thus becomes more urgent to use the smallest possible dose of I^{131} to prevent piling up of radiation effect. The need for reduced tracer doses of I^{131} in investigative studies of hyperthyroidism has been brought out above.

Some notice is required of the striking, though independent, decreases in basal metabolic rate, serum precipitable iodine, and radioiodine uptake by the thyroid observed at twenty-four hours after repeated tracer doses of I^{131} in patients whose hyperthyroidism has been otherwise unaffected. The failure of the level of serum precipitable iodine to decrease parallel to the fall in uptake of radioiodine in this group appears explicable. It may be a function of time. A decline in serum iodine level in patients successfully entering remission is generally not seen until several weeks after the uptake of I^{131} has been diminished. The decrease in radioiodine uptake has thus been too brief and too limited in the failure group, to warrant the expectation of a corresponding drop in serum iodine level. On the other hand, dissociation between the function of iodine

uptake and hormonal release has been shown to be a consequence of radioiodine therapy (9), and may also explain the present divergence.

The depression of basal metabolic rate without corresponding change in the level of serum precipitable iodine in the persistently hyperthyroid group is somewhat more difficult to account for. Chance fluctuation in the basal metabolic rate or inaccuracy in its measurement is possible. Another possibility is that the basal metabolism is altered by changes in serum hormonal iodine level of a degree not as yet recognized as significant. This last seems reasonable in view of the fact that the basal metabolic rate is not seen to fluctuate significantly in the majority of ambulatory patients with hyperthyroidism. This tends to lend possible significance to this change in the minority.

The few instances of fall in serum precipitable iodine level in the group otherwise unaffected by the tracer doses would appear to be best explained by transient inhibition of hormone release from the gland consequent upon radiation effect. Dissociation from the function of iodine accumulation is suggested, or the possibility that relatively slight changes in iodine accumulation, if persistent, may become reflected in decreased hormonal release. There is no adequate explanation for the failure of the basal metabolic rate to decrease concurrently.

It is well known that patients with hyperthyroidism occasionally undergo spontaneous remission of the disease. The likelihood that the remissions obtained in this study represent such a spontaneous recovery rather than the result of radiation effect must be evaluated. Lerman (10) estimates the incidence of spontaneous remission in hyperthyroidism as 1 in 25. This figure is considerably less than the 1 in 4 incidence of remission in the present study. Spontaneous remission in hyperthyroidism is generally sustained. The remissions after repeated tracer dosage have not been sustained except in one instance. The time within which remission takes place is also significant. Spontaneous remission in hyperthyroidism occurs much less frequently than 1 in 25 within the six to eight weeks following the first visit to the clinic. By contrast, half the remissions in the present series took place six to eight weeks following the institution of treatment, and the rest within three months. This is about the same time interval elapsing after therapeutic doses of I^{131} before euthyroidism is obtained and favors the view that the improvement with tracer doses is a true radiation consequence. In the patient in whom remissions were effected by each of two series of 240 microcuries of I^{131}, identical time sequences for remission and recurrence were observed. This is strong evidence against the view that spontaneous fluctuations of the disease are responsible.

Finally, the results of this study imply that the observation by the occasional hyperthyroid patient that he "feels better" after a single diagnostic tracer test with I^{131} may be due to something more than mere suggestion. Some instances, at least, may represent temporary inhibition of the overactive thyroid from radiation of not much more than 30 to 100 rep.

SUMMARY

Twenty-four patients with toxic diffuse or toxic recurrent goiter were given several tracer doses of I^{131} repeated at weekly intervals, as frequently used in investigative work. Remission of hyperthyroidism resulted in 6 of the 24 patients from repeated tracer doses totaling as little as 240 microcuries without other medication, but in 5 of the 6 cases remissions were not sustained beyond two to three months. Decrease of toxicity without the achievement of complete euthyroidism was achieved in another 3 patients.

Striking changes in individual laboratory values occurred in the 15 patients failing to show any clinical response to the tracer doses of I^{131}.

Children appeared to be unusually sensitive to internal radiation effect from I^{131}.

The implications of the above observa-

tions in investigative and diagnostic use of tracer methods with I^{131} are discussed.

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SUMARIO

Efectos Terapéuticos de las Dosis Diagnósticas Repetidas de I^{131} en el Hipertiroidismo

Veinticuatro enfermos con bocio difuso o recurrente tóxico recibieron varias dosis despistadoras de I^{131} a plazos semanales, como se hace a menudo en la labor investigativa. Hubo remisión del hipertiroidismo en 6 de los 24 sujetos, debido a dosis despistadoras repetidas que no sumaron más de 240 microcuries sin otra medicación, pero en 5 de los 6 casos, las remisiones no se sostuvieron más de dos a tres meses. En otros 3 enfermos, obtúvose atenuación de la toxicidad sin lograr completa eutiroidia. En los 15 sujetos que no revelaron la menor respuesta clínica a las dosis despistadoras de I^{131} hubo notables alteraciones en ciertos datos de laboratorio.

Los niños se mostraron extrañamente sensibles a los efectos irradiatorios internos del I^{131}.

Los resultados de este estudio connotan que puede haber más que mera sugestibilidad en la observación de alguno que otro hipertiroideo de que "se siente mejor" después de una sola prueba despistadora con I^{131} para diagnóstico. A lo menos algunos casos quizás representen inhibición pasajera de un hiperactivo tiroides por la irradiación de no más de 30 a 100 r.e.p.

DISCUSSION

Harold W. Jacox, M.D. (New York, N. Y.): The data which Dr. Werner presented should be of interest to radiologists and to everyone who works with isotopes. He has shown that the cumulative effects of minute amounts of radiation may have a beneficial influence upon some radiosensitive toxic goiters, even though this improvement is not always maintained. His findings are not particularly surprising or new to radiologists who have used roentgen therapy for hyperthyroidism for years, since it is well known that some patients may be extremely sensitive to relatively small amounts of external radiation, even to the extent of developing myxedema from a single average exposure. His warning to be alert for the possible effects from the tiny amount of radiation involved in tracer studies is a timely one.

Robert R. Newell, M.D. (San Francisco, Calif.): I am very much interested in this project of treating the thyroid on a demand basis. It seems to me extremely logical. I am a little disappointed that this first trial did not show more brilliant results. I still think it might be discovered that with proper time relationship the treatment on the demand basis would be the thing. If the hyperactive thyroid takes up I^{131}, it knocks itself out, and if it knocks itself out, it will stop functioning and not take up any more. I still think that this is so logical that I would like to see more work done on it.

An Automatic Tissue Dose Computer for Use in Supervoltage Rotational Therapy[1]

WALTER S. MOOS, PH.D.,[2] and EDWARD W. WEBSTER, PH.D.[3]

IN THE RADIATION treatment of deep-seated tumors it is usual to employ multiportal therapy, defined as delivery of radiation to the involved region through several entrances. As the number of portals increases, this becomes eventually rotational therapy. The calculation of tumor dose in this case often requires, for reasonable accuracy, the approximation of the treatment to that of some fifteen or twenty equally spaced entry ports around the tumor, and for each port one must take account of intervening tissue thickness and inverse-square-law effects. A calculation of tissue dose at a single point is tedious, subject to human error, and may take as long as thirty minutes, while the calculation of an adequate isodose distribution in and around a given tumor may require one or more days. In any therapy program with a flow of twenty or more patients per month, the calculation of dose at one or more points of interest in a given treatment field may well require a person working full time. For these reasons, which are even more compelling if novel treatment routines are frequently employed, the automatic calculator to be described here was developed.

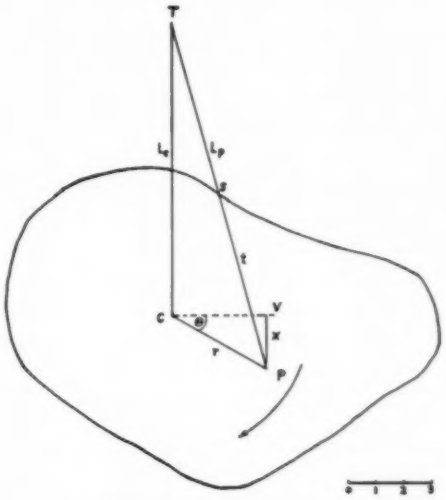

Fig. 1. Principle of dose computation in rotational therapy.

1. PRINCIPLES OF TISSUE DOSE CALCULATION FOR ROTATION THERAPY

In rotation therapy the tumor is continuously irradiated by the x-ray beam as the patient is rotated, so that the portal of entry is continuously changing. This means that the tumor will revolve about a fixed, usually central axis which lies in the central plane of the beam. In general, therefore, over a cycle of rotation the distance from the target to the skin will change, while the distance to the axis of rotation remains the same. For this reason, it becomes convenient to compare the tissue dose at any point with the dose delivered at the fixed axis in air with no tissue intervening. This latter dose may be conveniently measured during an actual treatment by a calibrated thimble chamber in the beam between target and patient. We will define *per cent tissue dose* as the average per cent ratio of dose received at the given point to the air dose measured at the axis of rotation.

Let us assume that a generalized body of section shown in Figure 1 rotates at constant speed about an axis through point C, perpendicular to the section, in a beam of radiation diverging from a point source T at a fixed distance, L_c, from C. Then the per cent tissue dose, $\bar{D}_p$, at any point P in the section may be calculated by adding the contributions of dose D_p at the point through n equal small sectors of rotation, each of which transmits an air dose of D_{ca}

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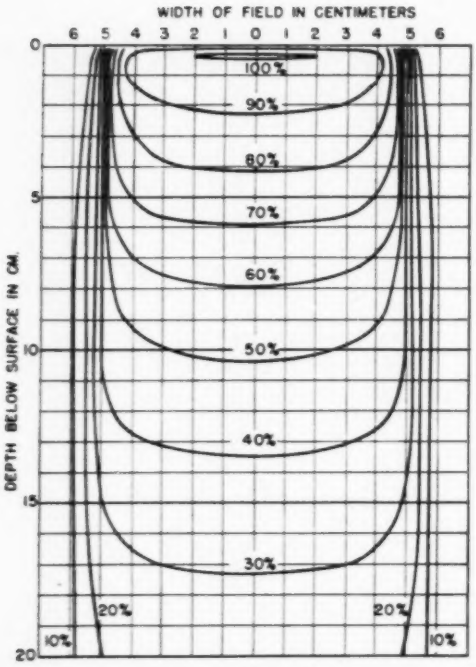


Fig. 2. Isodose chart for 2-mev constant potential x-rays, 100 cm. T.S.D., 10 × 10 cm. field, 9 mm. Pb equivalent filtration.

to the center of rotation, and dividing the total dose so obtained by the total received at the center of rotation. Thus the treatment may be approximated to n beams equally spaced around the body, delivering equal air doses to the center of rotation C. Then

$$\bar{D}_p = \frac{D_{p1} + D_{p2} + \ldots\ldots + D_{pn}}{nD_{co}} \times 100\% \quad (1)$$

The elementary tissue dose D_p for any position of P may be computed from knowledge of two factors, the distance, L_p, of P from the source, T, and the thickness $t = SP$ of intervening tissue, and may be expressed as

$$D_p = D_{co} \times \left(\frac{L_c}{L_p}\right)^2 \times f(t) \quad (2)$$

In Equation (2) $\left(\frac{L_c}{L_p}\right)^2$ is the reduction factor of dose at P compared with C due to inverse-square law only, and if r (distance PC) is small compared with L_c (*e.g.*, L_c = 100, r = 10), then $L_p = L_c + r \sin\theta$, where θ is measured as in Figure 1. Hence Equation (2) may be rewritten

$$D_p = D_{co} \times \left(\frac{L_c}{L_c + r \sin\theta}\right)^2 \times f(t) \quad (3)$$

$f(t)$, the absorption factor, is the factor by which the tissue dose at P is less than the air dose at C by virtue only of the absorption of the beam in intervening tissue.[4] To obtain this factor, isodose charts commonly available which give the variation of tissue dose with depth in tissue for a fixed focal skin distance (*e.g.*, Fig. 2) must be modified to eliminate inverse-square-law effects, *i.e.*, the dose at a point at a constant target distance for varying thicknesses of intervening tissue is required. Such a corrected dose distribution curve along the central axis of the beam is shown in Figure 3, which is constructed from Figure 2. As the point P rotates about C and moves away from the midline of the beam, the absorption factor $f(t)$ for a given thickness of tissue will change as indicated in Figure 2. Simplification of calculation results, however, if the isodose curves are assumed plane-parallel. This is nearly true for a well defined wide high-energy beam (6, 11, 12).

Equations (1) and (3) may be used to compute per cent tissue dose $\bar{D}_p$ graphically. Figure 4 illustrates such a computation for the actual section of Figure 1 rotating in a 2-mev, 10 × 10 cm. beam, at T.A.D. (target-axis distance) 125 cm. The stepped curve results from considering contributions of dose from each of 18 equally spaced angles of the beam relative to the body, measuring at each angle the distance $SP = t$, and the distance $PV = x = r \sin\theta$ (7). The average height of this curve gives the per cent tissue dose $\bar{D}_p$. Actually, of course, the dose received by the point P as the body rotates will vary continuously, as in the smooth curve of Figure 4, for which the mean height, the true value of

[4] This definition assumes that back-scatter may be neglected, which is only true for supervoltage radiation. See Section 4 (6, 11).

$\bar{D}_p$, is practically the same as the stepped curve (9).

2. PRINCIPLE OF THE COMPUTER

The basic object of the computer is to perform electronically and continuously for one rotation cycle (*a*) the evaluation of the two factors in Equation (3) which depend on the variation of the distances SP and PV in Figure 1; (*b*) the multiplication of these two factors; (*c*) the averaging of the resultant as indicated in Figure 4.

The computer is in essence a condenser which is charged by a varying current. The current simulates continuously the varying radiation dose-rate arriving at a given point in a body while the body rotates and is therefore controlled by the absorption and inverse-square factors. The total voltage recorded is proportional to the integrated dose received at the point. If the voltage scale is so chosen that this integration performed for the center of rotation, C, in air (*i.e.*, with zero intervening tissue) yields 100 units for one rotation of the body, then the voltage recorded for any other point in the section over one rotation will be the per cent tissue dose at that point.

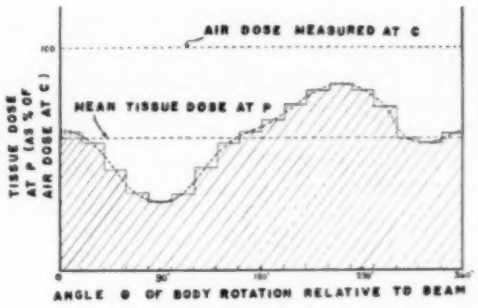


Fig. 4. Variation of tissue dose with beam angle at a point with 2-mev. rotational therapy.

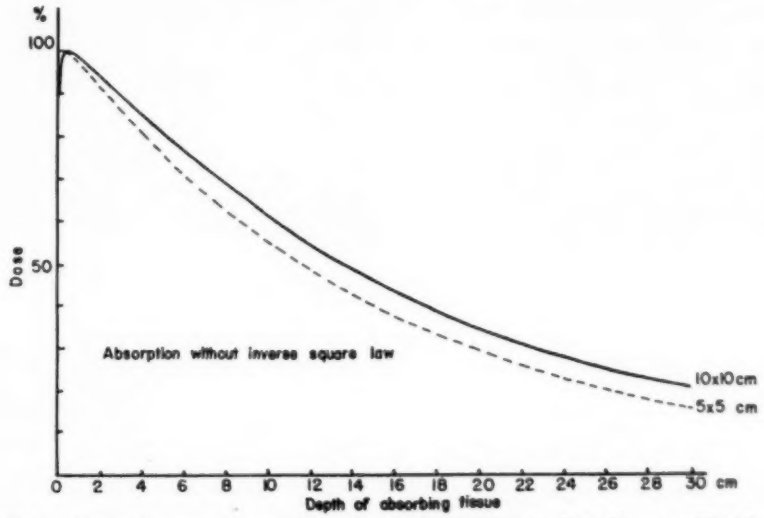


Fig. 3. Absorption curve in masonite for 2-mev roentgen rays for 10 × 10-cm. and 5 × 5-cm. beam

The variation in current corresponding to the inverse-square-law factor $\left(\frac{L_c}{L_c + r \sin\theta}\right)^2$ as the body rotates is produced by a continuously wound circular potentiometer, whose output follows the curves of Figure 5. The potentiometer arm rotates in synchronism with the body section, picking off the appropriate voltage corresponding to the angular position of PC relative to the beam direction. The amplitude of the inverse-square-law variation depends on the distance PC. Hence a second potentiometer whose output is calibrated in terms of $r = PC$ supplies the first potentiometer.

The variation in current corresponding to the absorption factor is reproduced by another potentiometer whose output corresponds to $f(t)$, as illustrated in Figure 3. The position of the sliding contact is controlled mechanically by the movement of S relative to P as the body rotates, it tact. Much mechanical simplification results *if P remains stationary so that the section rotates about P and not C, and SP merely describes a reciprocating motion along the direction of the beam.* The time rate of change of distance SP is not changed. Then the sliding arm can be connected

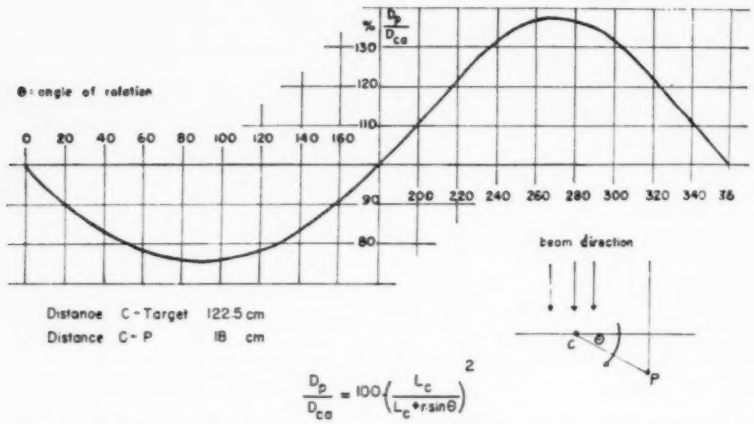


Fig. 5. Voltage output law for the synchronous sinewave potentiometer calculated for r = 18 cm. and L_c = 122.5 cm.

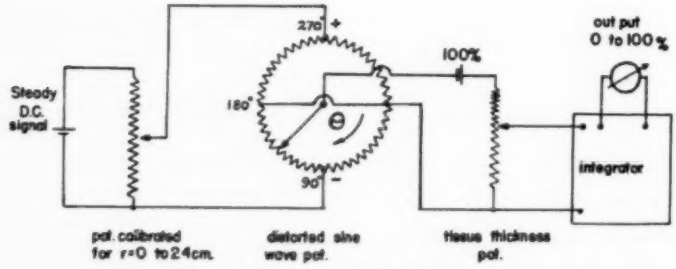


Fig. 6. Electrical principles of the computer.

being in the maximum output position when S coincides with P, neglecting the subcutaneous effect (11).

If, however, a body-section outline is set up on a turntable such that P rotates about C (Fig. 1), as actually occurs in rotation therapy, the mechanical arrangement for driving the absorption factor potentiometer becomes complicated. An arm, sliding through P and following the transverse motion of SP, must at the same time operate a potentiometer connected directly to a potentiometer which is fixed independently of the turntable.

Figure 6 shows the electrical principles of the circuit adopted with the inverse-square and absorption factors operating in turn upon the original steady signal, the resultant being integrated for one revolution of a body section.

3. DESCRIPTION AND OPERATION OF THE INSTRUMENT

The instrument depicted in Figure 7 is

Fig. 7. The computer in operation. A pelvic section is shown in position for computation of the isodose distribution in a rotational treatment of the cervix.

based on the above principles. It consists of a turntable rotated at a speed of one revolution per minute on which a full-size body section drawn on a sheet of paper may be mounted. The contact arm of the sinewave potentiometer, as previously described, is mounted on the drive shaft of the turntable. An arm equipped with a pointer to follow the body outline is mounted above the turntable and can move only backward and forward along a fixed line representing beam direction. The pointer is normally at the center of the turntable, so that the displacement of the arm from its zero position measures the intervening tissue thickness from the point P to the skin. This arm drives the absorption potentiometer as described. By means of a selector switch which controls the potentiometer voltage gradient, one of several absorption curves may be selected for this potentiometer, according to the field size and beam quality in use. A third potentiometer, as previously suggested, must be set to the relevant value of PC in centimeters. Stabilized direct current supplies and an electronic integrator complete the unit.

In order to find the per cent tissue dose at a point P located in a body section under irradiation, one must first draw the section outline and locate in it the center of rotation C. The point P for which the dose is required is centered on the turntable. Since the sinewave potentiometer is uniquely oriented with respect to the turntable at the start of a rotation, it is necessary to fix the body section to the turntable in a particular orientation. With the potentiometer at its median position and about to trace out its negative half-cycle, then the line PC should be perpendicular to the moving arm (the beam), and C about to move nearer to the operator (the target). In the present design, rotation is arranged to start with the potentiometer in this position, so that, as in Figure 8, the point C should be set along the perpendicular to the left of the pointer arm. The controls for the field size and

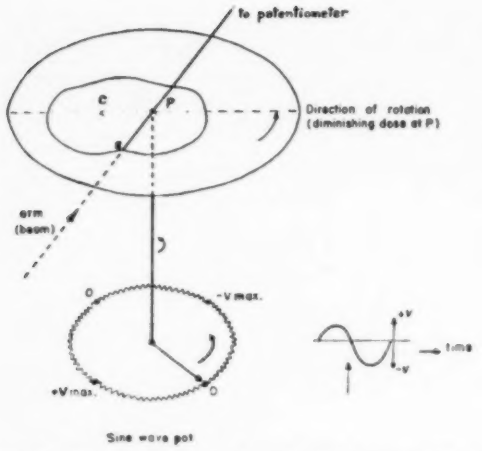


Fig. 8. Alignment of the body section with zero position on the synchronous sinewave potentiometer.

beam quality and for the distance PC are then set. The pointer is pulled out to the "skin" and the rotation started. The starting switch also applies the "dose" signal to the integrator, and is arranged to stop the turntable after exactly one revolution and to interrupt the integrator signal. The operator adjusts the pointer position by hand to follow the section profile as it rotates. The desired percentage dose is read directly on the meter. It is again stressed that this integration performed for the point C (*i.e.*, $PC = 0$) with the arm at its zero position should yield 100 per cent and the meter sensitivity should be adjusted (by a series resistance) to ensure this.

For the time, if any, that the point P is outside the treatment field during rotation, the integration may be interrupted by a further switch. In Figure 9, for example, integration of dose at point P will only be made over the sectors AB and ED.

4. PERFORMANCE AND LIMITATIONS

The performance of the instrument may be judged from comparisons made between automatic and graphical calculations for the same treatment. For example, in Figure 10 *a* and *b* a shoulder section is shown rotating in a 10 × 10-cm. field of 2-mev roentgen rays at T.A.D. 125 cm. A large number of point per cent tissue doses obtained by both methods is compared. The general level of agreement is ± 2 per cent, which is sufficient for clinical purposes.[5] With the automatic method the time required is perhaps one-fifteenth that with the graphical method.

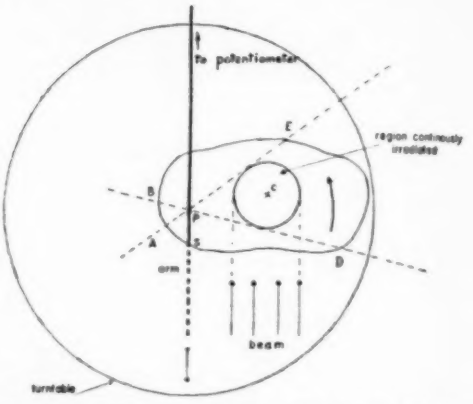


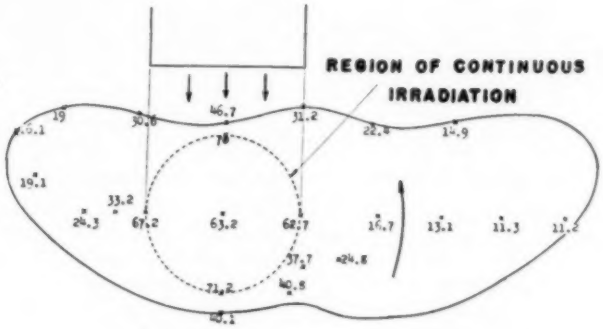
Fig. 9. Computation procedure for points outside the continuously irradiated region.

By the nature of the instrument, as set out in Sections 1 and 2, one cannot expect greater accuracy than by the graphical method. Ultimately the limitations are determined by the accuracy of the absorption curves and of the assumptions made. These are (*a*) that the target-axis distance is large compared with the distance PC, (*b*) that the isodose curves for an x-ray beam entering a block of tissue perpendicular to a flat face are parallel, and (*c*) that there is no back-scatter. For 2-mev rotational therapy at T.A.D. 125 cm., for which the computer was designed, these assumptions are reasonable.

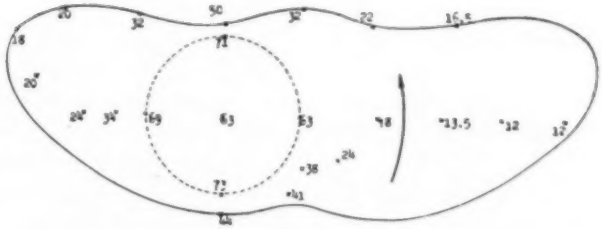
It is, however, the legitimacy of these assumptions which determines how far the scope of this design of computer may be extended to lower voltages and shorter T.A.D.'s. Below one million volts back-scatter becomes important, but this may be taken account of by allowing $f(t)$ to exceed 100 per cent at the skin, or more

[5] For a point near the circle of continuous irradiation there are added inaccuracies due to the uncertainty of the angle subtended by this circle at the point (Fig. 9).

simply by redefining per cent tissue dose in terms of *skin* dose at the axis of rotation. It is the marked curvature of the isodose curves at lower energies which sets the limit to the precise design above. Again, provided *PC* is less than 10 cm., the error for a T.A.D. of 50 cm. under assumption (*a*) is tolerable.



(a) Calculated graphically — time: 2 days



(b) Computed automatically — time: 1 hour

Fig. 10. Comparison of point doses through a shoulder section by graphical and automatic methods.

The most important limitation to the present design of computer is its inability to take account of lung or bone tissue, or of re-entrant areas of a body section. With supervoltages, the effect on soft tissue tumor dose calculations of the relatively small thicknesses of bone encountered in all body cross sections (the leg is the important exception), may be neglected. The effect of lung is, however, important. The radiographic density of lung tissue may be taken as 1/4. Hence, when the intervening tissue thickness *SP* (Fig. 1) contains lung tissue, the effective tissue thickness is considerably less than that measured. No method of compensation simple enough to warrant inclusion at this stage has yet presented itself.

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SUMARIO

Computador Automático de la Dosis Histológica para Empleo en la Rototerapia de Supervoltaje

La terapéutica rotativa viene a ser terapéutica a través de muchas puertas, llevada hasta el límite. El cálculo de la dosis tumor en este caso requiere para obtener una exactitud razonable, la aproximación del tratamiento al administrado por unas quince o veinte puertas de entrada igualmente espaciadas.

Para simplificar el problema se ha diseñado un computador automático de la dosis tejido, destinado a empleo en la terapéutica rotativa de supervoltaje. El computador es en el fondo un condensador cargado con una corriente variable. La corriente simula continuamente la distinta velocidad-dosis de irradiación que llega a un punto dado de un cuerpo mientras éste rota, hallándose, por consiguiente, regulada por la absorción y factores de razón inversa al cuadrado de la distancia. El voltaje total registrado guarda proporción con la dosis integrada recibida en el punto dado.

Los cálculos realizados han revelado acuerdo en términos de ± 2 por ciento con los obtenidos con métodos gráficos.

Discútense la aplicacion y las limitaciones del computador descrito.

Course of Testicular Injury Following Accidental Exposure to Nuclear Radiations

Report of a Case[1]

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ALTHOUGH CASES of testicular atrophy following exposure to ionizing radiations have been known since 1904 (1, 2) and were common in the Hiroshima and Nagasaki bombings (3, 4), little is as yet known of the ultimate fate of this lesion in man. The Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan is investigating this problem, but as yet no reports have been published (5). Experimental investigations of the effects of ionizing radiations on the testes of animals were begun in 1903 (6) and have been reviewed by Heller (7). Regeneration of the atrophic testis following irradiation has been studied in animals but not definitively in man, although many isolated case reports are to be found (8, 9, 10). Regeneration of human "germinal aplasia" from causes other than irradiation has been studied carefully, with the aid of testicular biopsies along with sperm counts (11). One case of irradiation testicular atrophy has been similarly studied (9). Sequential testicular biopsies along with sperm counts following exposure to radiation would seem to be the best investigative method available for determining the progress of testicular regeneration in man and allowing comparison with the results obtained from experimental animals. This technic was used in studying the following case of testicular atrophy due to ionizing radiations.

CASE REPORT[2]

The patient, aged 34, married and the father of one child, arrived ambulatory at the hospital shortly after an accidental exposure to nuclear radiations composed of slow and fast neutrons and gamma and beta rays of various intensities and energies. The dosage received was estimated to be equivalent to 390 r of 80-kv. x-rays and 26.4 r of gamma rays to the total body. The dosage is described in this manner inasmuch as this particular combination of more familiar types of radiation best represents the dosage distribution produced by the original complex mixture of radiations. Appropriate factors for the varying biological effectiveness of the original radiations have been included.

On admission the patient's blood pressure was at its usual level of 136/96 mm. Hg. His pulse was 100 per minute; respirations 20 per minute; oral temperature 99.4° F. He appeared in good physical condition, calm and well oriented, and without any signs of recent injury. After several hours he became nauseated and vomited once. The nausea disappeared and the appetite returned twelve hours after exposure. Diarrhea did not develop. The blood pressure fell to 120/80 mm. Hg in fourteen hours and returned in twenty-four hours to 140/90. The patient was weak, tired, and prostrated for several ensuing days. On the fifth day his temperature began to rise and on the sixth day reached 102.6° F. At this time he was drowsy, anorexic, and constipated. His face was flushed. Therapy with penicillin was then started and continued through the eighth day. On the tenth day the temperature was again normal. Repeated blood cultures revealed no organisms at any time. During these ten days there was a loss of 10 pounds in weight. Fluid intake was maintained at greater than 2,500 ml. a day. The patient received 500 ml. of lyophilized plasma on the first and third days and 500 ml. of whole fresh blood on the third and fourth days. He was discharged to rest at home on the fifteenth day.

Other evidence of radiation damage of moderate degree was found. Numbness and loss of tactile sensation of the left hand developed during the second day and persisted for ten days. On the fifteenth day dryness of the mouth, forehead, left hand, and groin was noted. On the seventeenth

[1] Work done under the auspices of the Los Alamos Medical Center and the AEC.
Presented at the meeting honoring the occasion of the retirement of Evarts A. Graham, M.D., as Bixby Professor of Surgery, Washington University, St. Louis, Nov. 29, 1951. Accepted for publication in January 1952.

[2] This case is described more fully and discussed from points of view other than that of the testicular damage by Hempelmann (12, 13).

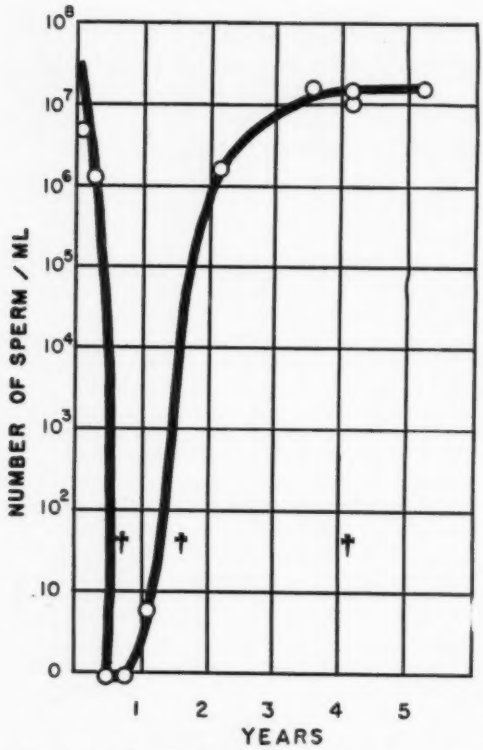

Fig. 1. Graph of the changes in sperm count over a five-year period following total-body exposure to nuclear radiations.

day the left side of the scalp became tender and loss of the hair and beard on that side of the face occurred. Regrowth of the hair of the head began about one month later and normal growth was obtained about five months later. Desquamation of the skin of the hands and feet occurred one month after exposure. Three months after exposure a prominent transverse ridge was seen in the fingernails of the left hand but was lost with continued growth of the nails.

Lymphopenia of less than 1,000 cells per cubic millimeter was present on the first day after exposure and persisted for the first year. During the second year the lymphocyte count reached 2,000 per cubic millimeter. Toxic granules appeared in the granulocytes during the first week and a leukopenia of 3,000 cells per cubic millimeter was reached in eight days. By thirteen days the total white blood cell count was within normal limits. The platelets fell from 900,000 on the first day to about 300,000 on the eighth day and thereafter rose slowly, reaching normal levels in about seven weeks. A tendency to hemorrhage did not develop except for epistaxis on blowing the nose about one week after exposure. The bleeding on this occasion was stopped immediately by cauterization.

Although the testes appeared to the patient smaller and to be higher in the scrotum about twenty months after the accident, physical examination showed them to be within normal limits in size. The only early evidence of testicular injury was obtained from a sperm count of 5 million non-motile sperm/ml. one month after exposure.

Two and a half years after exposure vision began to decrease in the left eye. This was found to be due to cataract formation in the posterior cortex of the lens. Now, five years after exposure, the only evidences of previous radiation damage are the cataract in the left eye and a low sperm count.

Because the patient and his wife hoped to have more children and wished to know the prognosis for future pregnancies following the first low sperm count, repeated sperm counts were done during the ensuing years and on three occasions biopsies of both testes were performed.

SPERM COUNTS

The number of sperm found in successive counts is shown graphically in Figure 1 along with the time of the three biopsies. The sperm in the first two determinations were all non-motile, and many abnormal forms were found. Since the second year 40 to 70 per cent of the sperm have been motile. Qualitatively abnormal forms have decreased progressively. The highest counts during the last two years were 16 and 17 million. However, four years after the exposure, an attempt on the part of the patient and his wife to have another child was successful.

TESTICULAR BIOPSIES

First Biopsy: The first biopsy was made of each testis approximately ten months after exposure. The testes seemed softer than normal but otherwise were not abnormal in appearance. Typical microscopic fields are depicted in Figures 2*a* and *b*. The interstitial connective tissue is edematous. The interstitial cells are normal in appearance and numbers. The small arterioles have enlarged collars of fibrous tissue, and the larger arterioles and small arteries show focal fibrous replacement of the media and the intima. The tubules are irregular in size and shape and are smaller than normal. There are foci of tubules in which the basement mem-

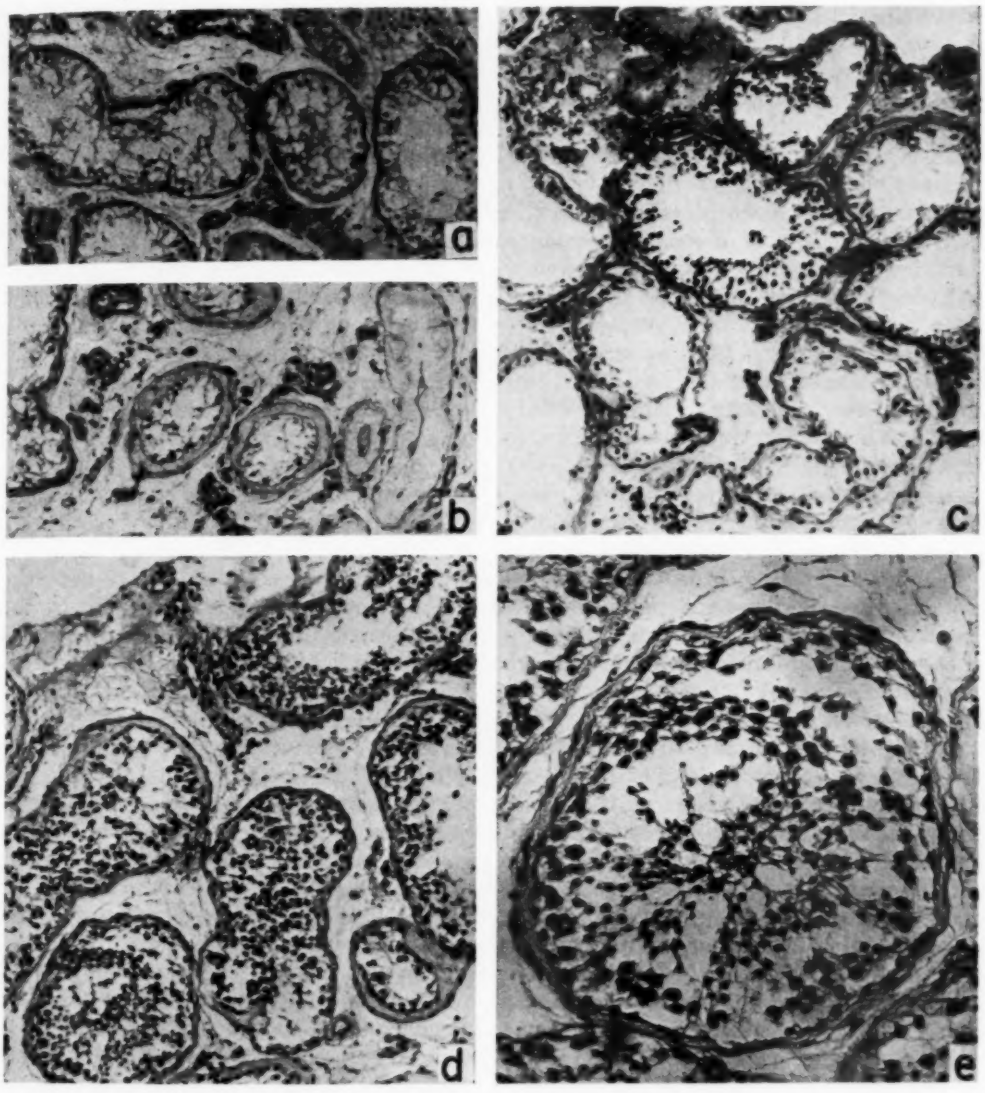

Fig. 2. Photomicrographs of the histologic changes found in three consecutive testicular biopsy specimens obtained over a five-year period after total-body exposure to nuclear radiations. *a* and *b*. Ten months after exposure, showing the marked tubular atrophy and thickening (×125). *c*. Twenty months after exposure, showing early regeneration of germinal epithelium (×125). *d*. Fifty months after exposure, showing spermatogenesis (×125). *e*. Same as *d* (×275), showing in greater detail the extent of spermatogenesis. For further description see text.

brane is greatly thickened at the expense of the lumen by eosinophilic material which appeared much like amyloid under low magnification but, under high magnification, proved to be made up of extremely fine strands of material resembling collagen. In some of these tubules the lumen is completely devoid of cells and reduced to a fine slit. The majority of the tubules are lined by a syncytium of sustentacular (Sertoli) cells having a fine lacy cytoplasm with ill-defined cell borders. The basement membranes of these tubules are increased in thickness, but whether this is due to

contraction of the tubule or actual increase in collagen cannot be determined. A rare tubule here and there contains two to four spermatogonia, recognized by the smaller round nucleus with darker staining qualities. A similar number of cells answering the description of prespermatogonia (7) are recognized. Amorphous eosinophilic debris fills the lumina of occasional tubules and, in several, the persistence of a few pyknotic nuclei give this debris the appearance of giant cells.

Second Biopsy: The second biopsy specimen was obtained nine and a half months after the first, approximately twenty months after exposure. The testes at this time were grossly within the lower limits of normal in size but of normal consistency. A typical microscopic field is shown in Figure 2*c*. The interstitial edema has subsided. The interstitial cells are normal in appearance and number. The small and large arterioles are similar to those seen in the first biopsy. Spermatogenesis is advanced but present in only a few sections of tubules. Foci of completely atrophic tubules with greatly thickened basement membranes are still present but are not as numerous as before. The majority of tubules are still lined by sustentacular cells. In some of these there was an eccentric thickening of the basement membrane. In this specimen (but not in the first) all gradations are seen of tubules obliterated by thickening of the basement membrane to tubules that have only a small portion of the membrane thickened. This appearance is, therefore, interpreted as evidence of the reversibility of the process of thickening of the basement membrane. The basement membrane of these "reconstituted" tubules, however, is thicker and more fibrous than normal, giving the impression that this change involves a condensation of the edematous fibrillar material.

The tubules showing spermatogenesis vary greatly from one another. In some there are only sustentacular cells and a few spermatogonia. In others spermatogonia-like cells are seen which, instead of having small round nuclei, have dark elongated nuclei with their long axes arranged circumferentially along the basement membrane. These are thought to be prespermatogonia undergoing hyperplasia. Other tubules show development of the primary spermatocytes and still others show formation of spermatids. Tubules showing this stage of spermatogenesis are rare, but in some of these maturing spermia were found. No mature spermia are seen. In occasional tubules necrotic primary spermatocytes and spermatids are found in various stages of degeneration. No explanation of this late sporadic necrosis could be found other than the theoretical one that the cells involved contain lethal genes as a result of the previous irradiation.

Third Biopsy: The third biopsy specimen was obtained fifty months after the exposure to the radiations. A representative microscopic field is shown in Figure 2*d*. The interstitial tissues are similar to those in the second biopsy specimen. Abnormal arteries can still be found. Spermatogenesis is present in almost all tubules. An occasional tubule is filled by necrotic cellular debris. Occasional tubules are still obliterated by the thickening of the basement membrane. The material thickening these membranes is still fibrillar in many instances, but the fibrils are not as fine as formerly and in other instances the material has the appearance of ground glass and the strands cannot be made out. If the two sections from both testes are considered as a whole, all stages of spermatogenesis are present. Considering individual tubules, however, spermatogenesis is not as abundant as normal in any. In a tubule containing maturing spermia, for example, no other cells other than sustentacular cells and spermatogonia are found. In other tubules one portion shows development through spermatids while the other half of the same tubule shows only a few primary spermatocytes. A few tubules in the left testis which presumably received more radiation than the right still show a persistent lining by sustentacular cells. Occasional tubules in both testes

show only spermatogonia while others show in addition a few primary spermatogonia and others show a few primary spermatocytes. In Figure 2*e* a single seminiferous tubule is shown at higher magnification to illustrate the actual paucity of spermatogenesis in these testes. This tubule is as far advanced in regeneration as any found. It also illustrates another finding that is not understood. At one side of the tubule the cells are growing as a sheet of cells with elongated nuclei arranged circumferentially. These cells appear to be primary spermatocytes and sustentacular cells and may be growing in this fashion because of increased tubular pressure secondary to tubular obstruction at some other point.

DISCUSSION

The sequential sperm counts and testicular biopsy specimens illustrate well the course of regeneration of the germinal epithelium in this case. The pathologic changes in the tubules correlate closely with the sperm counts and agree well with previous descriptions of these changes (3, 4, 11, 14). Both technics serve to show the extreme slowness of the process of regeneration of the germinal epithelium following exposure to ionizing radiations in man. They also show the steady progression of regeneration in this case. When these results are coupled with those reported for a similar case (9), the poor prognosis for recovery from such injury would seem to have to be altered to a more hopeful one. In neither case has the sperm count reached the 60 million/ml. level which is considered by some as the lower limit for a fertile man (11), but both have reached the 20 million/ml. level, which has recently been reported as the normal sperm count for 5 per cent of normal fertile men (15). From this point of view, the patient's wife's recent normal pregnancy would appear to be the expected result of this recovery of spermatogenesis and not a fortuitous event. While additional sperm counts and biopsies would not contribute much in this particular case, knowledge of the final extent of regeneration would enable one to use this case as a guide for prognostication in future instances of accidental radiation injury.

If this one human case can be used for comparison with the numerous animal experiments in which regeneration was studied, it becomes apparent that there is a vast difference between the rates of testicular regeneration in man and other animals. In the case presented here, regeneration was probably not complete after fifty months, while in rabbits after 800 r regeneration was complete in four months (7); in rats at 600 r, regeneration was complete in about four and a half months (7); and in mice at 400 r, regeneration was complete in three months (16). Regeneration began in rabbits at thirty days, in mice at twenty-one days, and in rats at thirty-one days (7). The weight of the atrophic mouse testis following 400 r began to increase after twenty-eight days (16), while regeneration after 300 r began microscopically in eight days (17). The first biopsy specimen in the human case ten months after the equivalent dose of 390 r of 80-kv. x-radiation showed only a rare spermatogonium, indicating that regeneration was just beginning at that time if it were present at all.

The reason for this marked difference in the rate of regeneration of the human and animal testis is unknown, although there are several theoretically possible explanations. Regaud (18) in 1910 found that it was more difficult to sterilize cats by x-rays than any other animal. He felt that this difficulty might be the result of the persistence of numerous primordial cells of the germinative layer of the seminiferous tubule in cats which are not found in equal numbers in the tubules of rats. Man might have less of these radioresistant, primordial cells than the lower mammals to account for the apparent greater sensitivity of his testis. The rarity of these cells in man might also account in part for the relatively slow production of spermatogonia in sufficient numbers to produce as rapid a rate of regeneration as in other animals. Species differences in metabolic rates may play

an important role in determining rate of testicular regeneration. The factors which determine the relatively late maturation of the normal human testis may also modify the rate of regeneration of the human testis. It is certainly possible that the severe radiation damage of the blood vascular system of the human testis may not only retard its regeneration but may also limit the extent to which this regeneration may proceed. Elucidation of the importance of these various factors unfortunately must await further clinical and experimental research on testicular regeneration.

SUMMARY

A human case of testicular atrophy following accidental exposure to nuclear radiations is presented along with the course of regeneration as determined by sequential sperm counts and testicular biopsies done over a five-year period. From this study it is evident that regeneration of the atrophic human testis following irradiation is extremely slow, although similar in cytologic detail to the rapid regeneration that takes place in irradiated testes of experimental animals. The factors which might conceivably play a role in determining this slow rate of regeneration are discussed briefly. On the basis of this case, the usual dismal prognosis for regeneration of the accidentally acutely irradiated human testis should be modified toward a more hopeful prospect.

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SUMARIO

La Evolución de una Lesión Testicular Consecutiva a Exposición Fortuita a Radiaciones Nucleares

Preséntase un caso humano de atrofia testicular consecutiva a la exposición fortuita a rayos nucleares, junto con la evolución de la regeneración, determinada ésta por numeraciones sucesivas de los espermatozoos y biopsias testiculares verificadas durante un quinquenio. Por este estudio queda demostrado que la regeneración del testículo humano atrofiado a consecuencia de la irradiación es sumamente lenta, aunque semejante en sus pormenores citológicos a la rápida regeneración que tiene lugar en los testículos irradiados de los animales de experimentación. Discútense sucintamente los factores que podrían concebiblemente desempeñar algún papel en determinar esa lentitud en la regeneración. A base de este caso, hay que modificar en sentido más halagüeño el habitual pronóstico sombrío para la regeneración del testículo humano irradiado agudamente por accidente.

EDITORIAL

Radiation Effects on Bone

Several recent articles (3–7) have again called attention to the importance of radiation effects upon growing and adult bone. Whereas it was formerly thought that adult bone is one of the most radioresistant of normal tissues, it is now recognized that it is the soft-tissue components of the bone, such as the terminal blood vessels of the haversian and Volkmann's canals, which may be particularly affected by hyperemia and later by obliterative endarteritis. Another reason for the interest in this subject is the present tendency toward the use of higher and higher voltages for therapy, with delivery of increasing amounts of radiation to the deeper tissues. In spite of the fact that there is less differential absorption by bone from these higher voltages, nevertheless fractures have occurred following such irradiation just as with conventional cross-fire therapy, regardless of whether or not lateral pelvic portals were used. It should be remembered that the blood supply to the femoral head and neck comes from the deep pelvic arteries, whose caliber may be reduced by heavy irradiation aimed at controlling a neoplasm of the pelvic contents. Repetitive treatment tends to produce damage out of proportion to the amount given, probably because recuperative capacity is diminished by previous irradiation.

Although there may be direct radiation effects on osteoblasts and osteoclasts, the vascular changes are equally important and probably account for fractures in those bones subjected to stress and strain. In other bones the roentgen appearance and clinical course suggest disintegration of bone substance on a basis of aseptic necrosis from partial reduction of blood supply, and perhaps a relatively poor collateral circulation.

A possible explanation for the bone changes which follow irradiation is the production of hyperemia and osteoclastic activity. Hyperemia is followed by widening of the haversian and Volkmann's canals from persistent dilatation of the vessels and, if absorption becomes great, rarefaction or osteoporosis will result. The osteoporosis described by the pathologist, however, is an earlier phase than that seen by the radiologist. The femoral neck is porotic and brittle even though it looks strong roentgenographically, but any sudden strain or unusual stress may produce a fracture. The delay in the appearance of roentgen alterations may be due to the fact that bone is dense and shows a definite lag in its response to associated pathologic conditions, with respect to both degenerative changes and reparative processes. Osteoclasts probably play a secondary part, since it is likely that decalcification must first occur before the osteoclast can exert its phagocytic action. Decalcification is a poorly understood physiochemical phenomenon brought about by the tissue juices, or possibly by the indirect effect of the osteoclasts themselves. Actual death of bone may result as a direct effect of irradiation on bone cells, as well as vascular damage.

It has been shown that osteoblasts are more sensitive to radiation than osteoclasts. Some think that osteoporosis following irradiation may be the result of a disturbance in the normal balance between resorption and production of bone on account of the sensitivity of osteoblasts. Truelsen (10) extracted a small piece of bone at the fracture site with a

rotating trephine and found a few vessels whose peripheral layers showed slight hyalinization. Destruction of bone marrow was associated with a picture of osteitis fibrosa and necrosis. There was no cellular reaction and a complete lack of osteoblasts and osteoclasts.

It is also possible that these fractures have a simple mechanical origin, since there may be an uneven distribution of stress. There is resemblance between femoral and stress fractures. However, there is no satisfactory explanation why this fracture occurs in only a few patients. The factor of high dose effects can sometimes be excluded, but not always. It has been shown that for 200-kv. x-rays the energy absorption in bone is about 2.5 times that in soft tissue.

In some cases at operation, the femoral head is dislocated, necrotic, and avascular, with a clear line of vascular granulation tissue demarcating the necrotic portion from the rest of the bone. Sometimes, but not always, the pathologic changes show that the basic factor is endarteritis obliterans, with sterile necrosis of the bone and cartilage. It is not definitely established whether the fracture is due to the effect of radiation on osteoid tissue proper or on the vessels, with obliteration and secondary necrosis. It is probably due to both causes, varying somewhat with the patient, and with the timing of the treatments. Baensch (1) found sclerosis of large blood vessels, replacement of rarefied bone by connective tissue and pseudarthrosis but no tumor at autopsy. Our findings were exactly similar (2). Okrainetz and Biller (8) found "marked thickening of the walls of many blood vessels, some of which showed hyaline intimal necrosis, others complete obliteration without new bone formation." Stampfli and Kerr (9) feel that osteoporosis secondary to vascular absorption and osteoclastic activity is probably the predisposing cause, and that damage to the periosteum, blood vessels, and bone cells is a subordinate etiologic factor. Phemister (9) believed that both the bone and the soft parts of the femur were damaged, but not to the point of complete necrosis. He saw osteoporosis, fibrosis, and in some cases endarteritis, but in others no vascular narrowing or thickening. Osteoclastic activity was thought to be greater than osteoblastic.

All patients who complain of hip or thigh pain and difficulty in walking after heavy pelvic irradiation should be suspected of having fracture of the femoral neck, even though there is no upward displacement of the trochanter. Nailing seems to be the most successful method of treatment.

In a paper and exhibit presented at the meeting of the Radiological Society of North America in 1951, Drs. Wittenborg, Neuhauser, Berman, and Cohen (7) of Boston Children's Hospital restudied two to three years following treatment, a group of 34 patients who had received radiation in which the spine was included. Exposures in excess of 2,000 r to the spine invariably produced growth disturbances, the majority of which were associated with gross abnormality of contour of the vertebrae. Scoliosis rarely resulted if the irradiation of the spine was uniform. The degree of growth disturbance appears to bear a definite relationship to dosage and reciprocal relation to age. Most infants and children with malignant disease do not live long enough for severe retardation of growth to develop. A few, however, with neuroblastoma have survived. Benign conditions usually do not receive an amount sufficient to produce clinically significant damage, although an occasional case is reported. Most of the cases of severe retardation of growth in the extremities have come from prolonged irradiation over epiphyses for benign conditions, such as hemangiomas (3). The rate of delivery of the radiation and the over-all time are important factors in the production of injury. Radiation, if definitely indicated in infancy, can be administered so as to produce a minimum of

disturbance in the development of the spine. HAROLD W. JACOX, M.D.

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Radiological Research

A Letter to the Editor

Recent announcement has been made on behalf of the James Picker Foundation of the continued availability of Grants in Radiological Research and Fellowships in Radiological Research. *Grants in Radiological Research* are designed to encourage research offering promise of improvement in radiological methods of diagnosis or treatment of disease. *Fellowships in Radiological Research* offer research training for recent graduates (M.D. or Ph.D.) who, as a rule, are not more than thirty years of age and are entering upon investigative careers in the field of Radiology. In both instances the Foundation has expressed particular interest in the support of research directed toward the diagnostic aspects of Radiology.

Applications for Grants for the fiscal year 1953–54 must be postmarked not later than Nov. 30, 1952, and should be addressed to the Secretary, Division of Medical Sciences, National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C. Applications for Fellowships must be postmarked on or before Dec. 10, 1952; inquiries should be addressed to the Fellowship Office of the National Research Council.

The following letter bearing upon the opportunities offered by the Picker Foundation has been received in the RADIOLOGY office:

Dear Doctor Doub:

Investigators working in the field of Diagnostic Radiology have been neglecting an opportunity for support made available to them by the James Picker Foundation. This Foundation with a present capital of almost a million dollars has now disbursed approximately $100,000.00, most of it on projects concerned with radiation therapy. Up to the present about 60 per cent of the applications have been for primarily therapeutic projects, 22 per cent for borderline projects, and only about 18 per cent for primarily diagnostic projects. We believe that the founders have been glad to support therapy in the past and intend to continue to do so in the future, but agree with them that there should be a better balance between therapy and diagnosis.

There are now well financed private and government agencies prepared to support research in neoplasm but few donors are interested in research in diagnostic radiology that is not concerned with neoplasm. We, the undersigned, who with other radiologists from time to time have assisted in evaluating proposals submitted to the Picker Foundation, urge that investigators consider this fund when they need financial support for research in the field of diagnostic radiology.

PAUL C. HODGES, M.D.
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ROBERT J. REEVES, M.D.
W. EDWARD CHAMBERLAIN, M.D.
H. DABNEY KERR, M.D.
EUGENE P. PENDERGRASS, M.D.
WENDELL G. SCOTT, M.D.

ANNOUNCEMENTS AND BOOK REVIEWS

EASTERN CONFERENCE OF RADIOLOGISTS

The Eastern Conference of Radiologists will hold its next meeting at the Warwick Hotel, Philadelphia, Penna., on March 6 and 7, 1953. Radiologists who expect to attend this Conference are invited to write to Dr. Rolfe M. Harvey, Bryn Mawr Hospital, Bryn Mawr, Penna., for advance registrations.

RADIOLOGICAL SOCIETY OF NEW JERSEY

The officers of the Radiological Society of New Jersey for the current year are Dr. Peter Gianquinto, President; Dr. Vincent Whelan, Vice-President; Dr. Nicholas G. Demy, 912 Prospect Ave., Plainfield, Secretary; and Dr. Salomon Silvera, Treasurer.

OHIO STATE RADIOLOGICAL SOCIETY

At the recent annual meeting of the Ohio State Radiological Society held at the Mansfield-Leland Hotel, Mansfield, Ohio, the following officers were elected: Dr. Edward C. Elsey, Cincinnati, President; Dr. Austin J. Brogan, Dayton, Vice-President; Dr. Willis S. Peck, 1838 Parkwood Ave., Toledo, Secretary-Treasurer (re-elected). Dr. Frank A. Riebel, Columbus, was elected Member-at-Large for a three-year term.

OREGON RADIOLOGICAL SOCIETY

At a recent meeting of the Oregon Radiological Society, the following officers were elected for 1952–53: President, Boyd Isenhart, M.D., of Portland; Vice-President, Woodson Bennett, M.D., of Salem; Secretary-Treasurer, J. Richard Raines, M.D., 214 Medical-Dental Bldg., Portland 5.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

For its annual meeting in Denver, Aug. 7–9, the Rocky Mountain Radiological Society reports a registration of over 225 members and guests. The newly elected officers are: President, H. Milton Berg, M.D., Bismarck, N. Dak.; President-Elect, W. Walter Wasson, M.D., Denver, Colo.; 1st Vice-President, Warren B. West, M.D., Ogden, Utah; 2nd Vice-President, Donald H. Breit, M.D., Sioux Falls, S. Dak.; Secretary-Treasurer, Maurice D. Frazer, M.D., 1036 Stuart Bldg., Lincoln, Nebr.; Historian, John S. Bouslog, M.D., Denver, Colo.; Counsellor to the American College of Radiology, Maurice D. Frazer, M.D. The Executive Committee includes, D. Arnold Dowell, M.D., Omaha, Nebr.; Tom B. Bond, M.D., Fort Worth, Texas; Edward M. Hayden, M.D., Tucson, Ariz.

The next annual meeting will be held at the Shirley-Savoy Hotel, Denver, Aug. 20–22, 1953.

WASHINGTON STATE RADIOLOGICAL SOCIETY

The Washington State Radiological Society has elected the following officers for 1952–53: President, Dr. John W. Settle, Jr.; Vice-President, Dr. Richard Kiltz; Secretary-Treasurer, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1.

RADIOISOTOPE COURSES

The 30th, 31st, and 32nd basic courses in radioisotope technics in research will be offered by the Oak Ridge Institute of Nuclear Studies on Jan. 5, Feb. 2, and March 2, 1953.

Application blanks and other information on the one-month courses may be obtained from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

MALIGNANT DISEASE AND ITS TREATMENT BY RADIUM. By SIR STANFORD CADE, K.B.E., C.B., F.R.C.S., M.R.C.P., F.F.R.(Hon.), Surgeon, Westminster Hospital; Consulting Surgeon, Mount Vernon Hospital and Radium Institute; Lecturer in Surgery, Westminster Medical School and formerly Examiner in Surgery, University of London; Member of the Council, late Hunterian Professor, Arris and Gale Lecturer and Member of the Court of Examiners, Royal College of Surgeons of England; Hon. Member of American Radium Society; Consultant in Surgery to the Royal Air Force. With a Foreword by SIR ERNEST ROCK CARLING, F.R.C.P., F.R.C.S., F.F.R., Consulting Surgeon and Vice-President, Westminster Hospital. Second Edition, Volume IV. A volume of 544 pages, with 785 figures and 215 tables. Published by John Wright & Sons, Ltd., Bristol, England, and the Williams & Wilkins Co., Baltimore, 1952. Price $12.50.

PHYSICAL FOUNDATIONS OF RADIOLOGY. By OTTO GLASSER, Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; EDITH H. QUIMBY,

Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; LAURISTON S. TAYLOR, Chief, Atomic and Radiation Physics Division, National Bureau of Standards, Washington, D. C.; and J. L. WEATHERWAX, American Oncologic Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. Second Edition, revised and enlarged. A volume of 582 pages, with 58 tables, 112 figures, and an Appendix including 11 roentgen ray depth dose tables. Published by Paul B. Hoeber, Inc. (Medical Book Department of Harper & Brothers), New York. N. Y. Price $6.50.

ANNUAL REPORT ON THE RESULTS OF RADIOTHERAPY IN CARCINOMA OF THE UTERINE CERVIX. SEVENTH VOLUME. STATEMENTS OF RESULTS OBTAINED IN 1945 AND PREVIOUS YEARS (collated in 1951). Sponsored by American Cancer Society; British Empire Cancer Campaign, London; Cancerföreningen, Stockholm; Donner Foundation, Philadelphia; Landsföreningen mot Kreft, Oslo; World Health Organization. Editorial Committee: DR. J. HEYMAN (Editor), Stockholm, DR. M. DONALDSON, LONDON, and DR. JOE V. MEIGS, Boston. A volume of 288 pages. Published by P. A. Norstedt & Söner, Stockholm, 1952.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONERS' INDEX. Editors: SIR HENRY TIDY, K.B.E., M.A., M.D. (Oxon), F.R.C.P., and A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S. A volume of 476 pages. Published by John Wright & Sons Ltd., Bristol, and Simkin Marshall Ltd., London, 1952.

Book Reviews

AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON. By SIR THOMAS FAIRBANK, D.S.O., O.B.E., M.S., Hon. M.Ch.(Orth.), F.R.C.S., Consulting Orthopaedic Surgeon and Emeritus Lecturer in Orthopaedic Surgery, King's College Hospital; Consulting Surgeon, Hospital for Sick Children, Great Ormond Street; Emeritus Consulting Surgeon, Lord Mayor Treloar Orthopaedic Hospital, Alton; Honorary Consultant (Orthopaedic) to the Army. A volume of 410 pages, with 510 illustrations. Published by Williams & Wilkins Co., Baltimore, 1951. Price $10.00.

As the author suggests in the Preface to this work on skeletal diseases, the title may not be entirely accurate, since many of the affections considered are not generalized in the strict sense of the word, though all are characterized by multiple lesions. The term Atlas may also be misleading, inasmuch as the profuse illustrative material is in reality secondary to the descriptive text.

Some eighty conditions and syndromes are covered, although some of these are mentioned very briefly. These conditions the author has classified under the following general headings: (1) Congenital Developmental Errors; (2) Acquired Affections of Unknown Origin; (3) Conditions Due to Errors of Diet and Metabolism; (4) Conditions Due to Endocrine Errors; (5) Conditions Due to Infection or Toxaemia; (6) Conditions Due to Errors of the Hemopoietic and Lymphatic Systems; (7) Multiple Neoplasms. He has also supplied tables classifying those conditions which fall together because of certain outstanding features such as dwarfism, increased bone density, collapse of vertebrae, multiple fractures, and Milkman's syndrome.

The general plan of presentation includes an account of the condition under discussion, covering the etiology, clinical features, radiographic appearances, pathology, and general diagnosis, followed by numerous case reports well illustrated by radiographs, photographs, and sketches.

A short bibliography of pertinent references is given at the end of each chapter. A complete author index and a general index make the material readily available to the reader.

The inclusion of so many unusual and interesting conditions in one volume makes this book a valuable addition to the library of anyone interested in skeletal lesions.

INJURY OF THE XIPHOID. By MICHAEL BURMAN and SAMUEL E. SINBERG. A monograph of 92 pages, with 18 figures. Published by Columbia University Press, New York, 1952. Published in Great Britain, Canada and India by Geoffrey Cumberlege, Oxford University Press, London, Toronto, and Bombay. Price $3.50.

This monograph of less than one hundred pages is devoted to a small portion of the human anatomy to which little attention is usually directed.

The first section of the book is concerned with the general anatomical conformation of the xiphoid and its variations, following which the symptomatology produced by malformation of the xiphoid is described on the basis of published reports. One section is devoted to primary and secondary diseases affecting the xiphoid, which fortunately are rare. The remainder of the text is given over to injuries to the xiphoid and their treatment, with special consideration of the familiar steering-wheel injury. Much of the material is from the authors' own experience.

This book will be of special help to those who are interested in the diagnosis and treatment of traumatic cases. It throws light also on a group of obscure symptoms of the upper abdomen related to malformations of the xiphoid.

The illustrations are good, and a comprehensive bibliography and index are appended.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 15 East Monroe, Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Calvin L. Stewart, M.D., 2330 First Ave., San Diego.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, John B. Hamilton, M.D., 210 N. Central Ave., Glendale 3. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, G. A. Fricker, Sacramento Co. Hospital, Sacramento 17. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Rex Uncapher, M.D., 7720 Girard Ave., La Jolla. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly, at the University Club.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Ford Shepherd, M.D., 526 Soquel Ave., Santa Cruz. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Charles E. Duisenberg, M.D., Palo Alto Clinic, 300 Homer Ave., Palo Alto. Meets third Thursday at 7:45, January to June at Stanford University Hospital, July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wendell P. Stampfli, M.D., 1933 Pearl St., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, William A. Goodrich, M.D., 85 Jefferson St., Hartford 14. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, B. Bruce Alicandri, M.D., 20 Maple St., Springfield, Mass. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, A. Judson Graves, M.D., 2002 Park St., Jacksonville. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, Maurice Greenfield, M.D., Ingraham Bldg., Miami. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Albert A. Rayle, Jr., M.D., 478 Peachtree St. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert M. Tankesley, M.D., 218 Doctors Bldg., Atlanta. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, Col. Alexander O. Haff, Tripler Army Hospital, Honolulu. Meets monthly on the third Friday, at Tripler Army Hospital.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Elbert K. Lewis, M.D., 6337 S. Harvard Ave., Chicago 21. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, John A. Robb, M.D., 23 East Ohio St., Indianapolis. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, James McMillen, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and holds a scientific session in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Willis L. Beller, M.D., 700 Kansas Ave., Topeka. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Clark F. Miller, M.D., Central Maine General Hospital, Lewiston. Meets three times a year—Spring, Summer, and Fall.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, H. Leonard Warres, 2337 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, John R. Hodgson, M.D., The Mayo Clinic, Rochester. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 621 High St., Jackson 2, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Sidney Rubin, M.D., 410 Professional Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Francis O. Trotter, Jr., M.D., 634 North Grand Blvd., St. Louis 3. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Russell W. Blanchard, M.D., 1216 Medical Arts Bldg., Omaha. Meets fourth Thursday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Stanley M. Wyman, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 8:45 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Joseph J. La Vine, M.D., 259 North Grand Avenue, Baldwin, N.Y. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Harold W. Jacox, 622 W. 168th St., New York 32.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Robert J. Bloor, 260 Crittenden Blvd. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Walter J. Brown, M.D., Northern Westchester Hospital, Mount Kisco, N. Y. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, Waldemar C. A. Sternbergh, 1400 Scott Ave., Charlotte 2. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, H. Milton Berg, M.D., Quain & Ramstad Clinic, Bismarck. Meets in the Spring with State Medical Association and in the Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 1838 Parkwood Ave., Toledo 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harry K. Hines, M.D., 2508 Auburn Ave., Cincinnati 19. Meets first Monday of each month, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, W. S. Koller, M.D., 60 Wyoming St., Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Donald H. Rice, M.D., West Penn Hospital, Pittsburgh 24. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Henry E. Plenge, M.D., Spartanburg General Hospital, Spartanburg. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, John E. Whiteleather, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., Newell Hospital, Chattanooga 2. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, Claude Williams, M.D., Fort Worth. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Building, San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Jan. 23–24, 1953, San Antonio.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John N. Burkey, M.D., 555 Medical-Dental Bldg., Seattle. Meets fourth Monday, September through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. W. Moir, M.D., Sheboygan Memorial Hospital, Sheboygan.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Jean Bouchard, M.D. Assoc. Hon. Secretary-Treasurer, D. L. McRae, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 26, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPÍA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPÍA. *General Secretary*, Dr. Dionisio Pérez Cosio, Marsella 11, Mexico, D.F. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

PUERTO RICO

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542 Santurce, Puerto Rico.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Diaphragm—Hernia

The Musculoskeletal System

Gynecology and Obstetrics

The Genitourinary System

Technic; Contrast Media

RADIOTHERAPY

RADIOISOTOPES

RADIATION EFFECTS; PROTECTION

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Hydrocephalus from Overproduction of Cerebrospinal Fluid (and Experiences with Other Papillomas of the Choroid Plexus). Edgar A. Kahn and John T. Luros. J. Neurosurg. **9:** 59–67, January 1952.

There are three generally accepted ways in which hydrocephalus can be produced: first, through oversecretion from the plexuses; secondly, through the interposition of an obstruction in the cerebrospinal pathway; thirdly, from impairment of absorption.

A case is presented of a papilloma of the choroid plexus which produced a hydrocephalus apparently as a result of increased secretion of cerebrospinal fluid. Ventriculograms revealed a symmetrical dilatation of the entire ventricular system. Air was present in the basal cisterns, indicating that no obstructing lesion was present. At the time of the report all symptoms of increased intracranial pressure had been absent for five years following excision of the papilloma.

Five additional cases of benign papilloma and one of adenocarcinoma of the choroid plexus are presented, but only the patient mentioned above had a survival period of five years and is assumed to be cured. One patient was alive one year postoperatively and had no symptoms of recurrence. Another lived nine months postoperatively and recently died. Two patients died after two years, and 2 died in the immediate postoperative period.

Roentgen therapy has been used so infrequently that its effectiveness cannot be evaluated. It is possible that a beneficial effect may be attributed to diminution of the over-production of cerebrospinal fluid.

Three roentgenograms; 4 photomicrographs; 1 photograph.

HOWARD L. STEINBACH, M.D.
University of California

Hemiplegia and Thrombosis of the Internal Carotid System. Arthur R. Elvidge and Alois Werner. Arch. Neurol. & Psychiat. **66:** 752–782, December 1951.

Thrombosis of the internal carotid vessels should be recognized as a clear-cut clinical entity which is increasing in importance. The authors report a series of cases and discuss the differential diagnosis.

In 1937 Egas Moniz and his co-workers published the first clinical report of 4 cases of internal carotid artery thrombosis. In each case the condition had been mistaken for a space-occupying lesion; diagnosis was made by cerebral angiography.

The authors' report is based on 10 cases, 6 of thrombosis of the internal carotid artery and 4 of thrombosis of the middle cerebral branches. In each instance the diagnosis was made by angiography. Following completion of the report, occlusion of the internal carotid system was demonstrated in 3 additional cases, bringing the number of cases of thrombosis of the internal carotid to 8 and of the middle cerebral branches to 5.

Thrombosis of the Internal Carotid: The patients with thrombosis of the internal carotid ranged in age from twenty-five to fifty years with onset of symptoms from the twentieth to the fiftieth year. The symptomatology varied from patient to patient and included recurrent paralyses, hemiplegia, epileptiform seizures, aphasia, headache, visual disturbances, fainting spells, and memory impairment.

With one exception, these patients were studied by pneumoencephalography as well as angiography, and all but one showed enlargement of the lateral ventricle on the side of the lesion. Ventricular study elsewhere showed bilateral enlargement of the ventricles in one instance. These findings are said to correspond to a cerebral atrophy of some degree. From the angiographic findings it was discovered that the commonest site of thrombosis of the internal carotid artery was just distal to the bifurcation of the common carotid artery. The authors note that "although cerebral angiography enables one to see such fine details as local encroachment into the lumen of the vessel, it is not of much help so far as small cortical vessels are concerned. They are too inconstant in their topography and in the way they branch, and too irregular in the way they fill with dye to enable one to tell in a given case whether the lack of filling is merely accidental or whether some are thrombosed. Furthermore, a 'normal-appearing arteriogram' is not sufficient evidence for the statement that there is no thrombosis among the smaller vessels."

In all but 1 of the 8 cases the left carotid artery was involved. Larger series of cases have shown an average proportion of 2:3 of occlusion on the left side. Men are more frequently affected than are women.

The feature most commonly presented by the patients is a contralateral hemiplegic syndrome. The upper limb is more affected than the lower. Recovery begins in the legs but leaves residual weakness in the fingers. In young patients with thrombosis, the mental condition is good in the early stages as compared with the hemiplegia, which is often severe. The patients were in good general condition, without cardiac abnormality or blood pressure elevation. The authors conclude that there are no signs or symptoms pathognomonic of occlusion of an internal carotid artery. The diagnosis can be made on the basis of the arteriogram alone or combined with ventriculography. In cases of hemiplegia, however, where there is decrease in pulsation of the carotid artery, the diagnosis of thrombosis is strongly favored.

In the differential diagnosis, disseminated sclerosis neoplasm, and subdural or intracerebral hemorrhage merit primary consideration. However, the authors feel that the main differential problem is not so much between internal carotid artery thrombosis and neoplasm as between thrombosis and intracerebral hemorrhage.

Thrombosis of the Middle Cerebral Artery: The patients with thrombosis of the middle cerebral artery ranged from six to forty-eight years of age and in all the hemiplegia was of sudden onset. As in cases of internal carotid thrombosis, there were varied associated symptoms. The pneumo- and electroencephalograms were similar to those found in the internal carotid group. "... there is not a single neurological, roentgenographic, ventriculographic, or electroencephalographic sign which could be said to be pathognomonic of thrombosis of one or the other branch of the internal carotid artery which could not occur when the thrombus is located in the internal carotid itself, and *vice versa*. The only means of locating the thrombosis, aside from careful palpation of the carotid pulsation, is cerebral angiography."

The etiological factors leading to thrombosis of the

internal carotid system are discussed. These include embolism, thrombosis, Buerger's disease, acute infections, syphilis, trauma, and external compression by neoplasm. Signs and symptoms depend on the cerebral branches involved. The object of the various methods of therapy is to increase the blood flow through the collaterals from the opposite side and to prevent vasoconstriction on the same side.

Sixteen roentgenograms; 5 electroencephalograms.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Congenital Toxoplasmosis. Report of a Case and a Brief Summary of the Literature. Jerome Rabkin and S. N. Javett. South African M. J. **26**: 41–43, Jan. 19, 1952.

A case of congenital toxoplasmosis in a 4-year-old European boy born in the Belgian Congo is reported. The child was mentally retarded. Physical examination showed microcephaly and a mild ataxia of the right arm and leg, suggesting a cerebellar disease. Roentgenograms of the skull revealed widespread subcortical calcification in the brain. Serological tests on the mother and patient were positive. A younger sibling was normal.

One roentgenogram.

Neurosurgical Observations in the Multiple Sclerosis Syndrome. Samuel J. Rosner. J. Nerv. & Ment. Dis. **114**: 511–518, December 1951.

The triad of scanning speech, intention tremor, and nystagmus so common in multiple sclerosis may be imitated by lesions high up in the cervical cord area. The history of symptoms at first unilateral is suggestive. The level of the lesion was closely approximated by clinical study and careful sensory tests prior to myelography. Cervical myelography requires careful technic, patience, and experience.

The author reports on the results of myelography in 14 such cases. In 10 cases a definite lesion was shown. Nine were confirmed by surgery. These cases showed definite filling defects or block on myelography in most instances. At operation adhesions or small tumors were found pressing on the cord. Improvement was slow in some instances but in 7 of the 9 the results were definitely favorable.

Two roentgenograms.

BERNARD S. KALAYJIAN, M.D.
Detroit, Mich.

Advanced Atrophy and Enlargement of the Sella Turcica with Destruction of the Sphenoid. Bernard S. Epstein and Leo M. Davidoff. Am. J. Roentgenol. **66**: 884–893, December 1951.

Out of a large material, 50 cases of tumors within or near the sella turcica were selected, each showing pronounced sellar changes. The pathological processes responsible for these changes are listed as follows:

1.	Pituitary adenomas	28
2.	Intrasellar craniopharyngiomas	6
3.	Aneurysms of the internal carotid artery	4
4.	Lymphoepitheliomas with sphenoid destruction	2
5.	Carcinoma of sinuses or nasopharynx	1
6.	Nasopharyngeal lymphosarcoma	1
7.	Primary sarcoma of the sphenoid	1
8.	Ependymoma of frontal fossa invading sella	1
9.	Metastases from distant sites (breast, 4; prostate, 1; kidney, 1)	6

For purposes of comparison 10 cases of advanced sellar atrophy due to hemispheral neoplasms and 10 cases due to pronounced dilatation of the third ventricle were reviewed. Seven case reports, with accompanying films, are presented.

The clinical syndrome associated with sellar and sphenoidal destruction was fairly uniform where the process was not due to hemispheral or cerebellar tumors or dilatation of the third ventricle. Most prominent were diminution of vision and temporal field defects. Evidences of endocrine dysfunction were relatively uncommon even in patients with primary pituitary adenomas. The roentgenographic changes were readily observed on routine lateral stereoroentgenograms, but the extent of the destruction was much better delineated by means of midline laminagrams.

The most advanced destruction observed occurred with lymphoepithelioma, sarcoma of the sphenoid, and metastatic tumors. Of particular interest in the pituitary adenoma group was a granular type of destruction, observed in 8 cases. The atrophy of the sella turcica associated with hemispheral tumors in the cases chosen for comparison was advanced to the point of disappearance in some cases. Granular destruction was not observed in these or in the other 10 cases with posterior fossa or aqueduct block lesions.

Differential diagnosis will often depend upon the findings by pneumoencephalography or angiography. Sometimes a therapeutic trial of irradiation may be helpful. Relief of ocular symptoms without any repair of the bony structures may indicate a pituitary adenoma, while return of osseous density may indicate a neoplastic infiltration.

Nine roentgenograms.

I. EARL HOLMES, M.D.
University of Louisville

Arnold-Chiari Malformation. Leonard I. Malis, Ira Cohen, and Sidney W. Gross. Arch. Surg. **63**: 783–798, December 1951.

The Arnold-Chiari malformation is a caudal displacement of the brain stem, cerebellum, and spinal cord. There is considerable disagreement as to the pathogenesis and there is little concurrence as to the relation of platybasia and spina bifida.

A historical review is presented, dating back to 1891, when Chiari first described a child with hydrocephalus in whom the fourth ventricle was displaced to the level of the fifth cervical vertebra. Maldevelopment of the cerebellum and medulla associated with hydrocephalus and spina bifida was first described by Arnold in 1894. The first successful operation for the condition was performed in 1936 and subsequently reported by McConnell and Parker (Brain **61**: 415, 1938).

Little has been added to the original description from a morphological standpoint. The displaced structures are subject to vascular impairment, perhaps with cystic degeneration.

As to pathogenesis, a traction mechanism, whereby the cerebellum and medulla are presumably displaced as a result of fixation of the cord in the myelocele sac, is one concept. This, however, fails to explain the existence, in some cases, of cerebellar displacement without medullary displacement. Another theory is that the malformation is a result of chronic hydrocephalus and sim-

ply forms a pressure cone as seen in certain patients with neoplasms, but this does not explain how the malformation may occur in the presence of normal intracranial pressure. The authors feel that there is a primary change in the development of the hind brain and that this, in turn, will frequently produce hydrocephalus, which will then increase the deformity.

Clinically, about one-half of the reported cases (40 have been recorded in the literature) with headaches had exacerbation of pain upon movement of the head. Platybasia was present in 20 cases. Spinal fluid studies occasionally demonstrated a partial or complete block.

Ventriculography and pneumoencephalography do not help appreciably in the diagnosis. A definite diagnosis can be made myelographically. Proper surgical treatment can offer a relatively good prognosis to these patients. The surgical procedure is described.

Three cases are presented in which the diagnosis was suggested clinically and substantiated by myelography, with successful surgical treatment.

Six roentgenograms; 3 photographs; 1 chart.

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Radiological Changes in the Skull in Dystrophia Myotonica. J. E. Caughey. Brit. M. J. **1**: 137–139, Jan. 19, 1952.

Dystrophia myotonica is characterized by muscle wasting and muscle weakness, with which there may be associated other dystrophic lesions, as cataract, gonadal atrophy, and frontal baldness. The author bases his report on 13 clinically certain cases of dystrophia myotonica. Most of these have been previously reported. They are here recorded with special emphasis upon the radiological observations. In assessing the findings, a pituitary fossa with a sagittal diameter less than 9 mm. and/or a vertical diameter below 6 mm. is classified as "small"; a pituitary fossa with measurements below 6 mm. and/or 4 mm. sagittally and vertically, respectively, is considered "very small."

In the 13 cases studied, the pituitary fossa was small in 7 and very small in 5. Thickening of the calvarium (up to 1.5 cm.) was present in 9 instances. Hyperostosis interna frontalis et parietalis was found in 9 patients, and in 3 of these this finding was pronounced. In 8 cases, the paranasal sinuses were enlarged. Prognathism was present in 2 patients.

The author concludes that these changes in the skull, *i.e.*, small pituitary fossa, thickening of the calvarium, hyperostosis, and enlargement of the paranasal sinuses should be accepted as variable features of dystrophia myotonica.

Two roentgenograms.

I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Hyperostosis Frontalis Interna. Two Contrasting Cases. Sherwood Moore and Archie D. Carr. J. A. M. A. **148**: 199–200, Jan. 19, 1952.

The already troublesome roentgenologic correlation of thickening of the inner table of the frontal bone with clinical observations (Morgagni's syndrome) is further complicated. Two patients with hyperostosis are contrasted. Both were chronic invalids, suffering from intense headaches. One was twenty-two years old when first seen, thin, and white. The other was fifty-five, very obese, and a Negro.

In the younger patient observations were continued over a period of more than twenty years, during which the vault of the skull almost doubled in thickness but the thickening of the orbital plate, observed on the first examination, regressed until it was of normal appearance. This decrease in the thickness of the orbital plate with increasing age was observed in 114 patients with hyperostosis frontalis interna and in 813 normal controls.

Three roentgenograms.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Fibrous Dysplasia of Facial Bones and Paranasal Sinuses. Hans Brunner. Arch. Otolaryng. **55**: 43–54, January 1952.

Fibrous dysplasia involving the paranasal sinuses and facial bones is not very common. Among 67 cases of fibrous dysplasia reported by Schlumberger (Mil. Surgeon **99**: 504, 1946. Abst. in Radiology **49**: 518, 1947), 2 were of the mandible, 7 of the maxilla, and 2 of the frontal bone. The author presents 2 cases, 1 of the maxilla and the other of the frontal bone.

In the first case the clinical symptoms were tearing, proptosis, displacement of the left eye, redness of the skin of the left cheek, and paresthesias of the left cheek. There was a fibrous hyperplasia of the left maxilla. In the roentgenograms there was seen, in addition, a dense clouding of the left frontal and the left anterior ethmoid sinus. It was thought that the latter was likewise involved by fibrous dysplasia, inasmuch as there was no clinical evidence of a chronic infection. At operation, the left maxillary sinus was found to be filled with cancellous bone, which on the x-ray films seemed to be sclerotic bone. A piece of newly formed bone was removed, but the defect rapidly filled with new bone. This, the author states, is apparently typical of the disease.

In the second case the area of the right frontal and ethmoid sinuses was replaced by newly formed cancellous bone. The symptoms were tumor formation at the forehead, the inner angle of the eye, and the supraorbital arch, displacement of the eye, and bulging of the roof of the orbit toward the anterior cranial fossa. The fibrous dysplasia had apparently encroached on the left frontal sinus, proving that fibrous dysplasia of the facial bones is not strictly unilateral.

The surgical and x-ray findings in both of these cases seemed to indicate that the respective sinuses had been entirely obliterated by newly formed cancellous bone. This is the usual but not the only explanation. The author believes that, while in some persons fibrous dysplasia may cause an obliteration of paranasal sinuses, in others it prevents the normal development of the sinuses by producing a newly formed tissue which occupies the space destined for them. This concept explains absence of the sinus observed even in young persons. It likewise explains the fact that a radical removal of the newly formed tissue in fibrous dysplasia of the sinuses, as a rule, is not possible unless the facial bone harboring the involved sinus is itself largely removed, an operation which would not be justified.

The x-ray findings are entirely different when a bone next to a sinus becomes involved by fibrous dysplasia. Two cases of fibrous dysplasia of the malar bone are reported briefly; in one the diagnosis was definite, in the other likely. In both cases the maxillary sinuses appeared to be dilated rather than obliterated in the roentgenograms, which presented the findings of *pneumo-*

sinus dilatans. It is questionable, however, whether or not there was an actual dilatation of the sinuses. The ear canals in both cases were narrow, owing to exostoses and to fibrous hyperplasia of the malar bone. It is thought likely that in this latter condition there is encroachment upon the maxillary sinus as well as upon the ear canals. If, however, the tissue formed by fibrous dysplasia is cancellous bone with poorly calcified trabeculae, the tumor bulging into the maxillary sinus does not cast a shadow on the film. Thus, the impression of a dilatation rather than an obliteration of the sinus is created. In both of these cases the disease extended into the malar process of the temporal bone; in other words, it was not strictly monostotic. In the last case the dysplasia of the malar bone was associated with tumors of the oral mucosa and of the tongue, on the same side as the dysplasia. It is probable that these tumors were fibromas, but the patient refused to have one removed for examination.

Four roentgenograms; 4 photographs; 1 photomicrograph.

Calcification of the Laryngeal Cartilages. Jacob H. Vastine, II and Mary Frances Vastine. Arch. Otolaryng. **55**: 1–7, January 1952.

A few years ago the authors reported a study of ossification of the costal cartilages in identical twins (Am. J. Roentgenol. **59**: 213, 1948). They concluded that, since an almost identical pattern or design of ossification occurs in the corresponding cartilages of identical twins, the pattern taken must be transmitted directly by the genes rather than be subject to any acquired factor, such as disease, mineral deficiency, or metabolic disturbance. The investigation has now been extended to the laryngeal cartilages. Lateral roentgenograms of the neck obtained in five pairs of identical twins showed that the deposition of calcium in the cartilages is strikingly similar in each pair. The configuration of the hyoid bones and of the cervical spines is also similar.

Ten roentgenograms; 5 photographs.

The Mechanism of Deglutition (Second Stage) as Revealed by Cine-Radiography. J. B. deC. M. Saunders, Cooper Davis, and Earl R. Miller. Ann. Otol., Rhin. & Laryng. **60**: 897–916, December 1951.

High-speed cineradiography is a prerequisite for the analysis of the second stage of deglutition, so rapid is the sequence of motion. Ordinary radiographic technics, such as fluoroscopy and the use of "spot" films, are inadequate and have proved misleading.

The authors made cineradiographic studies in one group of patients at the rate of 60 frames per second and in a second group at 30 frames per second. For the latter group they used a 35-mm. Bell and Howell motion picture camera with Biotar. f.85 lens, to photograph the fluoroscopic screen. Linograph film, which is very sensitive to green light and capable of being developed to reasonably high contrast, was found to be most satisfactory. The camera was synchronized with the fluoroscopic unit by means of a 1/8 h.p. motor with a commutator which interrupted the transformer primary circuit so that films were produced only during one-half of each revolution of the commutator. The Machlett tube (Dynamax 25 AA) was operated at 100 kv., 140 ma.

The subjects employed included normal adults and a few patients suffering from derangements of deglutition. The material swallowed was either thick or fluid barium, water, or air. Observations in 7 cases are presented.

The findings are summarized by the authors as follows:

"Normal human deglutition involves essentially an initial rise of the larynx, a vigorous backward thrust of the base of the tongue, followed by a wave of pharyngeal constrictor muscle contraction.

"The piston-like action of the tongue may be sufficient to project fluids into the esophageal opening before contraction of the pharyngeal constrictors. Solids, however, are propelled through the pharynx mainly by these constrictors.

"The bolus is prevented from entering the larynx by the sphincteric action of the laryngeal aditus and vestibule, the elevation of the larynx and the trapdoor movement of the epiglottis.

"The second stage of deglutition, therefore, may be divided into the following phases: (*a*) elevation of the larynx; (*b*) the posterior thrust of the base of the tongue; (*c*) the initial postero-anterior movement of the epiglottis; (*d*) further elevation of the larynx; (*e*) final descent of the epiglottis; (*f*) sphincteric closure of the laryngeal aditus; (*g*) passage of a peristaltic wave down the pharyngeal constrictor muscles; (*h*) opening of the superior end of the esophagus; (*i*) the anterior movement (return) of the base of the tongue to the resting position; (*j*) return of the epiglottis to the upright position; (*k*) descent of the larynx to the resting position."

Eleven roentgenograms, with accompanying diagrams.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

THE CHEST

Systematic Employment of Increased Pulmonary Pressure (Method of Valsalva) in Thoracic Radiology. G. Brouet, P. Y. Paley, J. Marche, and M. Castillon. J. franç. méd. et chir. thorac. **6**: 73–76, 1952. (In French)

The Valsalva maneuver (expiration against the closed glottis) results in decreasing the size and increasing the delineation of the heart and great vessels. As a consequence, questionable vascular shadows such as prominent hilar vessels are more clearly seen, and the outline of mediastinal and bronchogenic tumefaction is more clearly demonstrated. Roentgenograms are reproduced to show the appearance with and without use of the Valsalva maneuver in patients presenting prominent pulmonary arterial shadows, enlarged mediastinal nodes, and bronchogenic carcinoma. [Although this is not mentioned specifically, the method is also of value in pulmonary arteriovenous fistula.—C. M. N.]

Ten roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

On the Reliability of the Reading of Photofluorograms and the Value of Dual Reading. E. Groth-Petersen, A. Lovgreen, and J. Thillemann. Acta tuberc. scandinav. **26**: 13–37, January 1952.

The authors, senior officials in the Danish Anti-Tuberculosis Association, decided to investigate the magnitude of individual variation in the reading of photofluorograms; they studied two series taken during routine mass surveys.

The films were interpreted independently by three

experts of long experience. The first series consisted of approximately 2,500 minifilms, of which about 310 were classified as technically unsatisfactory, leaving 2,181 considered as technically adequate by all three readers. Those reported as showing abnormal shadows numbered, respectively, for the three readers, 36, 87, and 110. While one reader thus interpreted three times as many positives as another, the two did not always agree as to which were positive. Actually, all three agreed on this point in only one-tenth of the cases.

The authors classify two of the readers as "radical case finders, who refer people for further examination on the basis of the least suspicion"; the third is classified as more conservative, and his "diagnosis is therefore rarely overruled by the other readers." The authors state: "Our results did not surprise our American colleagues, but to us Danes it was shocking that the disagreement should be so great, and we tried to lay the blame on defective quality of films." They therefore analyzed another similar group of minifilms, carefully excluding all which were technically inadequate. The results were essentially the same as in the first series.

The authors describe their method for deciding which of the minifilms are truly positive and which are probably negative. They discard a group of cases on which agreement could not be reached, or questionable cases, and make further analysis of the remainder. This group included 26 truly positive and 2,122 truly negative. On studying this selected group of material, the radical interpreters still detected only 20 out of 26 positives (77 per cent), while the conservative reader detected only 54 per cent. An additional or fourth reader was introduced at this stage, and the average number of truly positive films so interpreted by all four readers was only 68 per cent. In other words, an average of 32 per cent of positives is overlooked, a figure identical with that previously published by Garland, Yerushalmy, and others in this country (see Radiology **52**: 309, 1949).

The authors review the type of roentgenographic findings which were overlooked. To their astonishment, they found that extensive as well as small lesions were missed. Indeed, only 5 of the 26 positive cases showed lesions classified according to Danish standards as "minimal."

The authors then studied the benefit of dual reading and found that they were able to pick up an additional 4 cases on the average second reading. In other words, while only approximately 18 of the 26 truly positives had been detected on the first reading, 22 were detected on the second reading. This represents a gain of 50 per cent of the cases missed, or a gain of about 15 per cent in all cases.

The penalty, of course, for this additional detection was an additional number of false positives. This was not very great, however, and amounted to only 2.5 false positives for each true positive detected on the dual reading.

The authors stress the fact that the purpose of minifilm surveys is to detect positive cases and that therefore missing a significant number of such renders the value of the survey very small. As in the case of the American workers, the authors write "To skeptics, one must say: Try it yourself."

In the summary the authors again stress the value of dual reading and state that in Danish survey work today all films are double-read. They add: "The reliability of the photofluorographic examination is less than was expected."

Thirteen tables

L. H. GARLAND, M.D.
Stanford University

Chest Surveys of the Aged. Edmund G. Beacham and Stanley H. Macht. Dis. of Chest **21**: 102–107, January 1952.

The authors report the findings in three surveys made of infirmary patients in the Baltimore City Hospitals. In 1942, 670 persons were studied with 35-mm. films, which were interpreted by an epidemiologist from the Division of Tuberculosis of the National Institute of Health. In 1945 the survey was repeated, 636 persons being examined with 70-mm. photofluorograms, interpreted by a phthisiologist. Finally, 581 persons of the same group were surveyed in 1949; 70-mm. films were used and the interpreter was a radiologist.

The observations in the three surveys were as follows:

Survey	Healthy Chests	Tuberculosis	Other Conditions
First	71.1%	13.0%	15.8%
Second	87.1%	7.7%	5.1%
Third	80.7%	14.6%	4.6%

These results are held to indicate over-reading on the part of the epidemiologist (first survey), under-reading by the phthisiologist (second survey), and a middle course by the radiologist.

The few articles which have appeared in the literature lead one to feel that a high incidence of active pulmonary tuberculosis might be found in a mass chest survey of an infirmary for the aged. One would think this to be especially likely in a public institution where all of the patients are indigent cases. The exact opposite proved to be the case. Eighty-five persons with positive findings in the 1949 survey were referred for careful study, and of this group only 3 had active pulmonary tuberculosis, 64 inactive tuberculosis, and 18 other conditions. This low incidence of active tuberculosis is attributed to careful screening before admission.

The authors found the percentage of retakes in the aged is about six and a half times that in the average population, due to the technical difficulties encountered and the high incidence of residuals of diseases of earlier life.

Four tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Importance of Visibility of Normal and Pathologic Bronchial Tree in the Diagnosis of Tuberculous Pulmonary Cavities. P. Viallet, P. Combe, L. Chevrot, and M. Viallet. J. de radiol. et d'électrol. **33**: 90–92, 1952. (In French)

The diagnosis of tuberculous cavitation is often incorrectly made. Since there are no pathognomonic images, the diagnosis is one of probability and the true problem becomes one of differential diagnosis.

First, it is necessary to eliminate contours artificially created by skin, bone, pleura, and vessels. If one recognizes a true air-containing image, there must then be eliminated gas-containing bullae in the digestive tract, subcutaneous tissue, pleura, and mediastinum. Once having determined that the air-containing image is within the lung, one must eliminate clear images pertaining to a part of the bronchial tree. Bronchography

is of value in the relatively normal bronchial tree, but not invariably in pathologic conditions. Fluoroscopy, radiography, and especially tomography may be of great value.

Under optimum conditions the thickness of the bronchial wall, bronchiectatic dilatation, and bronchiolar distention by air may be delineated. When the image of the air-containing area is perpendicular to a bronchus, the presence of true cavitation is quite likely. Permeability to iodine-containing contrast media, retention of fluid, and the presence of a draining bronchus favor the diagnosis of cavitation. Once this is established, the diagnosis of tuberculosis awaits demonstration of the tubercle bacillus. The differential diagnosis includes pulmonary cyst, bullae occurring in the course of staphylococcic and streptococcic infections as well as by bronchial compression by tuberculous nodes, bronchial dilatation, pulmonary abscess, ruptured hydatid cyst and cavitating neoplasm. The importance of establishing the true pathologic status is that it is the prelude to proper therapeutic procedure.

Two figures. CHARLES M. NICE, M.D.
University of Minnesota

One Hundred Cases of Pulmonary Exeresis for Tuberculosis. W. Bronkhorst and J. J. Hirdes. J. franç. méd. et chir. thorac. **6**: 12–21, 1952. (In French)

A report is made of 100 cases in which resectional surgery was carried out for tuberculosis between November 1949 and October 1950. The series included 23 pneumonectomies, 58 lobectomies, 5 upper lobectomies combined with superior segmental resection of the lower lobe, 1 lobectomy and decortication, and 13 segmental resections. In place of the terms "operable" and "inoperable" the terms "curative operation" and "palliative operation" are used. "Curative operation" denotes that the only apparent focus or foci of disease may be removed, or that the principal focus or foci may be removed. If obvious areas of disease remain, the operation is designated "palliative."

Of the 100 patients treated, the operation was considered curative in 81. Results are classified as "very good" if clinical cure with adequate pulmonary function is obtained, "good" if clinical status and pulmonary function are satisfactory but occasional positive sputum or insufficient pulmonary expansion remains, and "insufficient" if sputum remains positive or new foci of disease become evident. In only one case was the result "bad"; this patient exhibited resistance to streptomycin and P. A. S., and Conteben (TB[1]) was not sufficient protection during lobectomy to prevent development of a bronchial fistula and empyema. Among the 81 patients undergoing curative operation, results were very good in 87.7 per cent and good in 8.7 per cent. Of 19 patients undergoing palliative operation, results were very good in 36.8 per cent and good in 47.3 per cent.

Before operation 12 patients had sputum negative on direct examination and repeated culture; in 30 the sputum was negative on direct examination but positive on culture, and in 58 it was positive on direct examination. After operation these figures were 81, 16, and 3, respectively. The three patients with sputum remaining positive to direct examination were in the group undergoing palliative operation. Since administration of streptomycin during and after surgery is important, it is better to avoid production of resistance to streptomycin by attempting to foresee those cases in which surgery may be indicated and withhold the drug until the time of operation.

That many patients had rather severe forms of tuberculosis is shown by the fact that 35 had cavitation and 20 had ulcerating caseous disease. It is preferable, however, to operate when the disease process is relatively stable.

After surgery, 87 patients had no complications. Six patients had intrathoracic hemorrhage; in 2 bronchial fistulas developed and in 1 a fistula of the thoracic wall; 4 suffered from pulmonary thrombosis or embolism with one death.

This is an interesting paper. Such reports will be of even more value when a longer follow-up study is available.

Nine tables. CHARLES M. NICE, M.D.
University of Minnesota

Primary Atypical Pneumonia. An Analysis of One Hundred Twenty-Three Cases; Report of One Fatality; Review of Fourteen Cases Treated with Aureomycin. Sidney Finkel and B. H. Sullivan, Jr. Dis. of Chest **21**: 55–69, January 1952.

The authors describe the clinical features of 123 cases of primary atypical pneumonia studied during the first three months of 1949 at an Army General Hospital, 14 of which were treated with aureomycin, with prompt response (eighteen to sixty hours). The symptoms, serology, pathology, and roentgen findings are described, and reports of 4 of the aureomycin-treated cases are presented. One death occurred, and a history of this case with the necropsy findings is also included.

The roentgen findings are described as "shadows frequently extending out from the hilar regions and appearing as mottled infiltration and areas of increased uneven density of varying size. These changes represent endobronchial proliferation, peribronchial nodulations, interstitial infiltration, or a combination of all these processes. Occasional small collections of fluid appear in the interlobar fissures or in the costophrenic angles. Resolution is manifested by thinning of the septa or interstitial tissues, thus enabling the air to be seen again in the lobule; this usually starts first at the periphery and progresses towards the hilum."

In the authors' series, upper lobe lesions were present in 7 per cent, central lesions in 4 per cent, and basal lesions in 89 per cent. Involvement was bilateral in 22 per cent of the cases. The upper lobe lesions may resemble tuberculosis.

Six figures; 1 table. HENRY K. TAYLOR, M.D.
New York, N. Y.

Roentgenologic Pulmonary Manifestations of Queensland Fever. L. G. Glücker and J. Munk. J. Fac. Radiologists **3**: 186–192, January 1952.

An analysis of the radiologic characteristics of pulmonary lesions of Queensland fever (Q fever) based on the x-ray examination of 85 serologically proved cases seen in the Haifa area of Israel is presented.

The dominating radiological feature was a circumscribed, usually rounded shadow of an exudative-pneumonic character, limited by interlobar septa if the lesion was near the septum. Subsequently the lesion decreased in density and homogeneity; and in its center there was seen a small shadow bearing the characters of the original lesion and surrounded by a zone of structural intensification. At this stage in some of the cases a

linear shadowing, linking the lesion to the hilus (drainage of the area), was noted. The central lesion gradually disappeared, but the residual zone of structural intensification sometimes persisted for many weeks.

Queensland fever cannot be differentiated radiologically from other exudative-pneumonic diseases, particularly from a primary tuberculous lesion, early tuberculous lesion, eosinophilic infiltration, etc. Features which may distinguish it from lobar pneumonia are the extent, localization, and the density of the lesion. Primary atypical pneumonia has a dominating interstitial infiltration manifesting itself in the first stage of the disease and lasting throughout all stages as structural intensification. Segmental distribution and the commonly present lobular, segmental, or lobar atelectasis due to bronchial obstruction may be present in atypical pneumonia but are absent in Q fever.

Nine roentgenograms.

LAWRENCE A. PILLA, M.D.
University of Louisville

Silicosis in the Ball-Clay and China-Clay Industries. R. W. Thomas. Lancet **1**: 133–135, Jan. 19, 1952.

Two cases of silicosis occurring in men employed in the English china-clay and ball-clay industries are reported. In 1 case x-ray examination of the chest showed generalized coarse discrete nodulation in both lungs, only the extreme bases being unaffected. There was no evidence of tuberculosis apart from a few calcified foci in the hilar nodes. The appearance was considered to be that of classical silicosis in the third stage. In the second case silicotuberculosis was discovered only at necropsy.

One roentgenogram; 1 photomicrograph.

Fungus Diseases of the Lungs. Review of Roentgenologic Manifestations. C. Allen Good. Texas State J. Med. **47**: 817–825, December 1951.

The roentgen manifestations of fungus diseases of the lungs are not sufficiently characteristic to permit specific diagnosis. Final proof of fungus infection depends on isolation of the organism from sputum, blood stream, or tissue. In any undiagnosed case of chronic pulmonary disease, however, fungus infection should be considered. This may produce a variety of radiographic changes which can readily be confused with tumor, pneumonia, or tuberculosis, and include: localized or disseminated fibrosis, calcification, cavitation, mass granuloma, hilar and mediastinal adenopathy, miliary infiltration, and pleural effusion.

Coccidioidomycosis is frequently asymptomatic, but when clinical disease is obvious the roentgenologic manifestations simulate atypical pneumonia. In 10 to 15 per cent of such cases, instead of resolving, the pulmonary infiltration of the acute phase persists as a nodule, cavity, or fibrotic scar. Cavities may develop in an area of acute pneumonitis, but the solitary, thin-walled, regular cavity which shows no surrounding reaction results from central necrosis of a persistent granulomatous nodule. These cavities are highly suggestive of coccidioidomycosis and are frequently asymptomatic. The commonest complaint is hemoptysis.

Histoplasmosis in its primary phase may produce localized or diffuse patchy or miliary infiltrations, frequently with hilar adenopathy. These may be present with mild symptoms, or none at all, and may resolve completely. Persistent nodules frequently calcify, and some workers believe that massive hilar or multiple peripheral or miliary calcifications are more commonly observed among positive histoplasmin reactors than among positive tuberculin reactors. It is important to note that in many cases of proved histoplasmosis there is no skin sensitivity to the antigen.

Actinomycosis, more frequently than other fungus diseases, extends across the pleural space and invades the thoracic wall, giving the ribs the appearance of osteomyelitis. Since *Actinomyces* is a common inhabitant of the mouth, it exists in many cases of chronic pulmonary suppuration as a secondary invader.

Other fungus infections briefly but informatively discussed in this review are blastomycosis, moniliasis, aspergillosis, torulosis, and geotrichosis. The article provides an excellent up-to-date orientation to the subject.

Fifteen roentgenograms.

D. D. ROSENFELD, M.D.
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The Roentgenological Picture in Chronic, Non-Specific Fibrosis of the Middle Lobe, with Special Regard to the Value of Planigraphy. Haakon Ødegaard. Acta radiol. **37**: 17–27, January 1952.

The author briefly reviews the work of Graham and others since 1948 on the middle lobe syndrome (see, for example, Paulson and Shaw: J. Thoracic Surg. **18**: 747, 1949. Abst. in Radiology **55**: 771, 1949), and reports on 20 cases examined at the University Hospital, Oslo, Norway.

Fifteen patients (75 per cent) gave a history of recurrent colds or persistent cough; hemoptysis occurred in 10 cases, and 5 were practically asymptomatic, having been discovered in the course of mass photofluorography or routine chest examination.

Planigraphic studies with emphasis on lateral examination were carried out in 18 of the 20 cases, and in 7 (38 per cent) a calcified lymph node was found adjacent to the middle lobe bronchus. Bronchiectasis was shown by both planigraphy and bronchographic studies in 10 cases, in 1 case by planigraphy alone, and in 2 by bronchography alone. In only one instance was abscess found in the middle lobe.

The author suggests that bronchial tumor will occlude the lumen bluntly or straight across, whereas lymph node pressure will cause compression from without, as described by Graham. The question is asked if one is justified in limiting middle lobe syndrome to cases of bronchial stenosis produced by lymph node pressure, since specific and non-specific infections may produce stenosis in the bronchial wall, and tumor may occlude the bronchial lumen in varying degrees.

Twenty-four roentgenograms.

E. H. PRICE, M.D.
Indiana University

Problems in the Diagnosis of Carcinoma of the Lungs. Stephen W. Brown. South. M. J. **44**: 1089–1091, December 1951.

It is pointed out that we have at hand satisfactory methods for the early diagnosis of lung cancer—roentgenography, bronchoscopy, biopsy, and cytological studies of bronchial washings. Nevertheless, valuable time is still being lost: (1) between the onset of symptoms and the first chest roentgenogram; (2) between the first suggestive roentgen evidence of carcinoma and the histologic diagnosis. In a series of 65 cases of

bronchogenic carcinoma, the average interval between the first symptoms and the first chest roentgenogram was found to be 6.1 months.

The roentgen findings that should suggest the diagnosis of lung cancer in a patient over forty years of age are: segmental or lobar atelectasis or emphysema, presence of a mass, a thick-walled cavity, or any unexplained lung abscess. All patients with pneumonia who do not recover promptly should be studied for bronchogenic carcinoma.

Thirteen illustrative cases are briefly reported.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Lung Cancer. Angiocardiographic Findings in 100 Consecutive Proved Cases. Israel Steinberg and Charles T. Dotter. Arch. Surg. **64**: 10–19, January 1952.

Angiocardiography does not produce conclusive diagnostic evidence of lung cancer but in many cases it can give conclusive evidence of inoperability. The authors performed the examination on 100 consecutive cases of proved lung cancer. In only 13 cases was no vascular abnormality found. In these the lesion either lay entirely within a bronchus or was situated too far peripherally to distort the vascular pattern. The changes which were observed in the other 87 cases varied from displacement and extrinsic pressure defects to polypoid invasion, stenosis, and occlusion of either the superior vena cava system or the pulmonary arteries. In 1 case involvement of the pericardium was diagnosed.

When invasion of a major pulmonary artery, the superior vena cava, or pericardium is found, a diagnosis of inoperability may be made, provided, of course, there is other evidence to show that the involvement seen is due to cancer of the lung.

Seven roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Further Observations on the Diagnostic Value of Pulmonary Angiography in Bronchogenic Carcinoma. Donald J. Schissel and Philip G. Keil. Am. J. Roentgenol. **67**: 51–56, January 1952.

In a series of 396 patients studied by pulmonary angiography, 40 cases of bronchogenic carcinoma were found. Three cases showed a normal vascular pattern. In 37 cases diminution of the vascularity within and distal to the carcinoma was demonstrated. Less frequent changes were obstruction or distortion of the superior vena cava, the pulmonary arteries, or their branches. Ten patients were of particular interest since bronchoscopy, biopsy, and bronchial washings were not diagnostic, while angiography permitted recognition of the pathological process. The results of the diagnostic procedures in these 10 cases are tabulated.

Two cases were regarded as false positives. In 1 there was a right upper lobe atelectasis as a result of a broncholith and chronic inflammatory reaction with scarring; in the other, atelectasis was due to obstruction of the left lower lobe bronchus by a submucosal osteochondroma.

Diminished vascularity as demonstrated by reduction in the size and number of vessels or delayed filling is not found in other parenchymal mass lesions. Emphysematous blebs produce diminished vascularity but are not associated with a mass and are usually multiple. A large inflammatory abscess will not show vessels in its cavity but will usually be surrounded by a zone of increased vascularity. It is conceivable that a small, completely intramural tumor obstructing a bronchus could produce atelectasis without diminution in the vascularity, but such a lesion has not been recorded.

Seven roentgenograms; 1 table.

DAVID C. GASTINEAU, M.D.
Indiana University

Phalangeal Metastases as a First Clinical Sign of Bronchogenic Carcinoma. Robert Strang. Brit. J. Surg. **39**: 372–373, January 1952.

The case presented is that of a 66-year-old man complaining of a swelling of the left ring finger. This is described as being the size of a golf ball, with uniform hyperemia of the overlying skin. A roentgenogram showed almost complete destruction of the middle phalanx and the appearance was suggestive of a tumor. Aspiration showed collections of carcinoma cells of the squamous-cell type.

In searching for the primary lesion a bronchogenic carcinoma of the left lower lobe bronchus was found. The patient gave a long history of asthma and bronchitis but these symptoms had not increased in severity recently. The finger was amputated to relieve the pain. Death occurred four months later as a result of the pulmonary lesion.

In the discussion the author points out the fact that bronchogenic carcinoma of the squamous-cell type has a peculiar tendency to form early secondary deposits in the phalanges. The digital swellings are frequently drained as inflammatory lesions.

Three roentgenograms.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Metastatic Carcinoma of the Lung to the Thumb. D. Richard Freni and J. H. Averill. Am. J. Surg. **83**: 115–116, January 1952.

The metastases of carcinoma may be bizarre. A case is reported in which an epidermoid carcinoma of the lung metastasized to the distal phalanx of the thumb. Four weeks after admission to the hospital with an incurable pulmonary cancer, the patient complained of pain and swelling of the left thumb. On examination the distal phalanx was found to be slightly swollen, tender to palpation, and dusky red in color, but with no local heat. Roentgenography showed a circumscribed osteolytic lesion at this site. The diagnoses considered were chronic felon with osteomyelitis and metastasis to the thumb. At operation the latter proved to be correct, and the thumb was amputated. Further x-ray studies revealed destructive lesions in the right frontal bone, right femur, and left acromion. The patient died about a month later. At autopsy other metastatic lesions were found in the liver, head of the pancreas, left adrenal, and right kidney.

Two roentgenograms; 1 photomicrograph.

Congenital Cystic Disease of Lung Associated with Anomalous Arteries. Frederick G. Kergin. J. Thoracic Surg. **23**: 55–65, January 1952.

The lung lesion described in this paper had two components, a maldevelopment of part of the bronchial tree to a lower lobe with an associated distribution of

arterial blood to the affected portion of the lung by way of an anomalous artery arising from the aorta. Pryce published the first comprehensive description in 1946 (J. Path. & Bact. **58:** 457, 1946), and in 1947 Pryce, Sellors and Blair made a further report on the condition. (Brit. J. Surg. **35:** 18, 1947. Abst. in Radiology **50:** 846, 1948). The bronchial maldevelopment may be of the nature of congenital bronchiectasis or more commonly a bronchopulmonary mass of cysts of bronchial origin surrounded by primitive lung tissue. The mass may be completely or incompletely separated from the rest of the bronchial tree.

Failure of development of the pulmonary arterial tree to the affected part occurs. The blood supply is oxygenated blood *via* an artery from the aorta. This anomalous vessel arises either above or below the diaphragm, passing to the lower lobe between the leaves of the pulmonary ligament. Pryce's theory of the development of the lesion is reviewed quite lucidly.

Thirty-one cases are reported in the literature and to these 5 are added. The 5 patients ranged in age from sixteen to sixty years. All complained of chronic cough with sputum. Three had hemoptysis. In all these cases at least one cyst communicated with a bronchus, and in all the roentgenograms showed an air-fluid level in one or more cysts. The characteristic roentgen picture is that of cystic masses, usually showing fluid levels, in the left lower lobe, although either lower lobe may be involved.

The author believes that the roentgen findings, associated with a history of long-standing lung disease and physical findings indicating density in the lower lung field should make one suspicious of this condition. The importance of the diagnosis lies in the fact that surgical removal of the diseased segment or lobe is curative, and the surgeon should be aware of the fact that there is a fairly large anomalous artery supplying the involved lung. In 3 cases reported in the literature death occurred because of hemorrhage from the anomalous vessel.

Seven roentgenograms; 3 photographs.

C. J. CORRIGAN, M.D.
St. Paul, Minn.

Cyst of Lung Associated with Anomalous Pulmonary Artery. Charles B. Ripstein and George A. Degenshein. Arch. Surg. **64:** 131–134, January 1952.

There are several theories as to the origin of an anomalous pulmonary artery and associated lung sequestration. The one cited here is as follows: Embryologically the pulmonary artery develops in a vascular plexus which has connections with both dorsal and ventral aortae. Because of embryonic shifts, the connections to the dorsal aorta are normally disrupted. If there is a delay in shift or if the dorsal aorta captures a bulbous tip of the bronchial tree, the subsequent development is that of an anomalous artery, and this is usually associated with traction on the captured lung bud. If this vessel grows without disruption or sequestration, it remains merely an anomalous vessel entering a normal pulmonary lobe. If, however, the bulbous tip detaches from the lung bud, survives, and grows, sequestration of an accessory lobe results in association with the anomalous vessel. The sequestration may be complete, with an independent bronchus, or is may be incomplete, communicating with the adjacent lung.

The authors do not state whether most lung cysts are of this type or not, but it is obviously important for the thoracic surgeon to be on the lookout for anomalous vessels when operating for cystic disease of the lung. If such a vessel was divided without being seen and retracted below the diaphragm, hemorrhage might be fatal before it was recognized.

A single case is reported in which roentgen examination revealed multiple cysts in the left lower lobe. At surgery the anomalous vessel was seen and ligated.

Two roentgenograms; 1 photograph; 3 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Changes in Cases of Disseminated Lupus Erythematosus. Ivan Thorell. Acta radiol. **37:** 6–16, January 1952.

Fifteen cases of disseminated lupus erythematosus were studied by the author at the Military Hospital, Boden, Sweden. In 4 cases no roentgenologic changes were demonstrable, and in 3 such changes as were found were believed to be unrelated to the current disease. In the remaining 8 cases pleural or parenchymal changes, or both, were observed which appeared to be attributable to lupus erythematosus. Five of the cases with changes of a fundamentally similar character are reported.

All of this latter group showed pleural changes consisting in small unilateral or bilateral effusions and/or irregular pleural thickening. The pleural changes may vary in extent over a rather short time interval. The parenchymal changes include linear streaky areas of infiltration occurring subpleurally in peripheral portions of the lung; later, these become more generalized, with accompanying paratracheal and hilar lymphadenopathy.

The author believes that, although none of these changes is characteristic of disseminated lupus erythematosus, careful analysis of such findings should permit more accurate roentgen diagnosis of the disease.

Sixteen roentgenograms.

R. A. SILVER, M.D.
Indiana University

Roentgen Aspects of Pulmonary Arteriovenous Fistula. William B. Seaman and Alfred Goldman. Arch. Int. Med. **89:** 70–81, January 1952.

Over 65 proved cases of pulmonary arteriovenous fistula have now been recorded in the medical literature. The clinical features of cyanosis and clubbed fingers, associated with polycythemia and a pulmonary murmur, make the full-blown syndrome easily recognizable. With the study of more cases, however, it has become apparent that the classical clinical picture associated with a large pulmonary arteriovenous shunt and corresponding changes in the peripheral blood does not always occur. One or all of the prominent clinical manifestations may be absent, and the roentgen examination may furnish the only clue to the correct diagnosis. Recognition of the anomaly is of the utmost importance, since it is surgically curable.

Eight cases of pulmonary arteriovenous fistula are reviewed. Since in 4 of these the clinical and pathological features have already been adequately described by others (Goldman: Am. Rev. Tuberc. **57:** 266, 1948; Lindskog and associates: Ann. Surg. **132:** 591, 1950. Abst. in Radiology **57:** 449, 1951), the authors present here only a résumé of the clinical findings. They evaluate the roentgenographic technics and their role in the recognition of this lesion. The cases in the present

series were evenly divided between the sexes. Telangiectases and a family history of telangiectasis were present in 6 of the 8 patients. Only 1 case presented none of the characteristic physical signs or symptoms. In 4 cases cyanosis and polycythemia were absent, although 3 of these patients had hemorrhagic phenomena which might explain their lowered red blood cell count. Clubbed fingers occurred in 5 of the 8 patients; only 2 did not have a pulmonary murmur.

Conventional roentgenograms have demonstrated an abnormal pulmonary shadow in every case recorded. The mass is usually lobulated or round with smooth discrete margins and has a predilection for the lower lobes or the right middle lobe. Connecting the mass with the hilus are two or more sinuous, linear shadows which represent the dilated afferent and efferent blood vessels. These vessels are usually larger than the pulmonary vessels in the vicinity, and their course is more tortuous. The veins are more widely dilated than the arteries owing to transmission of arterial pressure directly into the veins. Intrapulmonary hemorrhage resulting from rupture of vessel walls may produce irregular densities and even segmental atelectasis obscuring the lesion. Even in this event careful observation of the vessels running from the hilus to the pulmonary opacity may give a clue to the true nature of the underlying lesion.

As was first emphasized by Lindgren (Acta radiol. **27**: 585, 1946. Abst. in Radiology **50**: 262, 1948), the vascular character of the lesion may be brought out by the use of the Valsalva and the Müller maneuvers.

Demonstration of the pulsatile nature of the tumor has not been consistently positive and has been described infrequently in the literature. In 2 of the authors' patients pulsations were demonstrated both fluoroscopically and by roentgen kymography. Small areas of calcification have been noted in the pulmonary mass, but too infrequently to be of diagnostic significance. The heart is usually not enlarged. Lindgren emphasized the relationship of the mass to the pulmonary vascular shadows as the most significant roentgen diagnostic sign of this lesion; this relationship can be definitely established by laminagraphy, which should be carried out in both the lateral and frontal projections whenever such a lesion is suspected. Laminagraphy may also demonstrate lesions not previously recognized in conventional films, as well as indicate the exact anatomical position in the bronchopulmonary segment. It is extremely difficult to differentiate pulmonary artery from pulmonary vein in the upper lobe by means of laminagraphy, but this may be done in the lower lobe by virtue of the origin from the parent artery at the hilus or the termination of the vein near the left auricle.

Subpleural lesions may easily escape detection, although diagnostic pneumothorax may prove helpful in demonstrating them. Bronchography is of value in differentiating saccular bronchiectatic cavities filled with secretions, which occasionally simulate roentgenologically an arteriovenous fistula.

With the use of conventional roentgenography and laminagraphy, a definite diagnosis of pulmonary fistula can be made in a large majority of cases without resorting to angiocardiography, but the authors feel that this latter procedure is warranted in every case in which surgical treatment is contemplated. Visualization of the pulmonary circulation and of the size and location of the involved vessels, as well as the identification of anomalous origins of the afferent artery or anomalous insertions of the efferent vein, may facilitate surgical measures. Of more importance is the demonstration of multiple lesions which may have been overlooked in both the conventional films and laminagraphic studies. In 2 of the authors' cases angiocardiography revealed lesions which had been unsuspected.

The differential diagnosis of pulmonary fistula is usually not difficult once the condition is suspected. The appearance of small fistulae may strongly resemble that of pulmonary metastases, primary lung tumors, benign cysts, tuberculomas, or bronchiectatic sacs filled with secretion, and diagnosis may prove more troublesome. The most important points are the recognition of the relation of the mass to the adjacent vessels and the proper evaluation of the tortuous bands connecting the parenchymal mass with the hilus. Laminagraphy is usually quite successful in demonstrating the vascular continuity of the abnormal pulmonary shadow.

Eighteen roentgenograms; 1 table.

Arteriovenous Fistula of the Lung and an Associated Hemangioma of the Vertebra. Case Report. James W. Nixon and John F. Perry. Dis. of Chest **21**: 108–116, January 1952.

The authors give the case history of a 26-year-old Latin-American male with a pulmonary hemangioma, or arteriovenous fistula, and an associated hemangioma of the third cervical vertebra. The chief complaints were pain in the neck and dyspnea on exertion. There was no history of injury to the neck. The dyspnea had been present since the age of eight. Cyanosis had also been noted in childhood.

The heart did not appear enlarged on physical examination, and the heart sounds were normal. A bruit was heard over the left chest posteriorly, unrelated to the cardiac sounds. There were clubbing of the fingers, cyanosis, and tenderness in the right post-auricular area and in the neck below the right mastoid. The red blood cell count was 9,280,000; hemoglobin 137 per cent.

A roentgenogram revealed in the left lower lobe a smooth rounded mass, 6 cm. in diameter, from which many dilated vessels extended to the hilus. The cervical spine showed a loss of normal lordosis and "demineralization with irregular mottled osteoporosis of C-3."

The clinical diagnosis was pulmonary arteriovenous fistula, and a neoplastic lesion involving C-3. Irradiation directed to the cervical spine resulted in marked improvement. On subsequent x-ray examination there was no demonstrable change in the appearance of the body of the vertebra, and this observation, together with the absence of any demonstrable primary tumor from which a vertebral metastasis might arise, led to a diagnosis of vertebral hemangioma.

Subsequently a left pneumonectomy was performed, followed by disappearance of the cyanosis. The aneurysm produced a localized bulge on the mediastinal surface of the left lower lobe. On cut section through the junction of the inferior pulmonary artery and vein, a direct communication between the two vessels was demonstrated. Each of the vessels measured approximately 3 cm. in diameter, and the communication 2 cm. in diameter.

Pulmonary arteriovenous fistula belongs to the group of hereditary hemorrhagic telangiectasia, and it is believed that in this case the vertebral hemangioma represented another manifestation of this telangiectatic

tendency. The etiology of arteriovenous fistula of the lung is unknown; it is congenital and there is a familial tendency. The lesion is usually progressive. Symptoms include cyanosis, dyspnea, hemoptysis, transient dizziness, cerebral manifestations of numbness, and paresthesias. There is clubbing of the fingers, and telangiectases of the skin and mucous membranes are frequently associated. X-ray examination of the chest demonstrates one or more circumscribed lobulated densities in the lung. Planigraphy and pulmonary angiography may reveal tortuous vessels leading from the hilus to the area of increased density.

The treatment is surgical. The prognosis in the untreated case is poor, the major threats being thrombosis and pulmonary hemorrhage. In the differential diagnosis one must consider polycythemia vera, as well as secondary polycythemia from a variety of causes. From the roentgen standpoint, cysts, adenomas, metastatic lesions, tuberculoma, and aneurysm of pulmonary artery branches must be excluded.

Three roentgenograms; 2 photographs.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Intrathoracic Goiter. F. Henry Ellis, Jr., C. Allen Good, and William D. Seybold. Ann. Surg. **135**: 79–90, January 1952.

Twenty-four cases of intrathoracic goiter seen at the Mayo Clinic, in which the entire tumor or its major portion was entirely within the thorax, are reviewed. The large majority of the patients were women over fifty years of age. Eighteen of the goiters were located on the right side, and 14 were situated in the posterior mediastinum or the posterior portion of the superior mediastinum. The incidence of this latter location is much higher than in the reported literature. The favorite position for this group was behind the superior vena cava, with the azygos vein forming the inferior border and the posterior thorax forming the posterior limit. Eleven goiters were found in this position.

The roentgenologic findings of significance (McCort: Radiology **53**: 227, 1949) are: (1) a smooth or only slightly nodular tumor mass which displaces and possibly compresses the trachea and esophagus; (2) upward motion of the mass on swallowing; (3) usually no pulsations in the mass (2 cases in this series showed pulsations and it was not apparent from the records whether these were transmitted or intrinsic). Calcification was present in 9 cases but was not helpful in specifically indicating that thyroid tissue was present.

The usefulness of I^{131} depends upon whether or not hyperthyroidism is present. In 2 cases tracer studies were of diagnostic aid. In most of the cases there was either a palpable thyroid gland or a history of a thyroidectomy. Only half of these patients had symptoms.

Thirteen illustrations including 10 roentgenograms; 1 table.

D. D. ROSENFELD, M.D.
Fontana, Calif.

The Investigation of Thymic Tumours in Myasthenia Gravis. R. A. Kemp Harper. J. Fac. Radiologists **3**: 164–175, January 1952.

There is no doubt that thymic tumor is present more frequently in patients with myasthenia gravis than in non-myasthenics. The author uses various technics for discovering these masses: fluoroscopy, frontal and lateral roentgenography, and tomography.

The tumors may be rounded, lobulated, or plaque-like. In the latter two varieties, tomography may be required to separate the tumor from the underlying aorta or pulmonary artery. Tumors may be situated over the hilar region and centrally placed so that they are completely hidden in the frontal view. Occasionally calcification may be observed. Certain of the thymic tumors metastasize, but the secondary masses are usually confined to the thorax, mainly to the anterior mediastinum and pleura.

The author stresses the need for investigation of the anterior mediastinum in all patients with myasthenia gravis and in any patient with an unusual shadow appearing either side of the hilar region.

Eleven cases are reported, with 32 roentgenograms.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Surgical Significance of Calcified Parabronchial and Paratracheal Lymph Glands. Elmer R. Maurer. J. Thoracic Surg. **23**: 97–110, January 1952.

The serious significance of the presence of calcified lymph nodes in and about the tracheobronchial tree probably has not received sufficient emphasis in the past. These calcifications may produce atelectasis by compressing the adjacent bronchus, with clinical and roentgen findings often identical with those in patients with atelectasis due to a primary carcinoma.

The finding of calcified lymph nodes by roentgenogram in and about the tracheobronchial tree is usually associated with dense scarring of the mediastinal and interlobar structures, and difficult surgical dissection at the time of operation can be anticipated. The mere presence of non-obstructing calcified lymph nodes about the lobar bronchi may necessitate the performance of more radical procedures than were preoperatively anticipated to remove lesions for which more conservative surgery is ordinarily recommended. As with other non-malignant lesions producing bronchial obstruction, complete excision of the destroyed portions of lung with the calcified lymph node will invariably result in a cure.

The danger exists that the calcified node may erode a large vessel, with serious or fatal consequences.

The author presents three cases. In the first, the calcified mass was actually within the left main bronchus, producing findings simulating a calcifying tumor. The second case was thought preoperatively to be a primary carcinoma. The third case was correctly diagnosed as a large tuberculoma in the right upper lobe, but at surgery a total right pneumonectomy was found necessary because of extensive scarring and calcification of tissue about the hilus.

The author feels that greater emphasis should be placed on these calcified paratracheal and parabronchial nodes by both roentgenologist and surgeon, because of the surgical difficulties implied by their presence.

Nine roentgenograms; 2 photographs.

C. J. CORRIGAN, M.D.
St. Paul, Minn.

Dynamics of the Heart: Observations by Angiocardiography. C. Wegelius and J. Lind. J. Fac. Radiologists **3**: 193–198, January 1952.

The authors believe that further development of angiocardiographic technic will aid in the study of cardiovascular dynamics. As a necessary solution to the problem, multiple films taken at the rate of 10 to 12

exposures per second are necessary, as well as radiography of the heart synchronously in two separate planes. In this way the individual parts which have been superimposed in one projection will be freely projected from one another in a second projection and may be examined separately. It is necessary to synchronize each pair of films taken in the two dimensions as well as to record their relation to the heart cycle by a simultaneous electrocardiographic recording.

An apparatus satisfying these prerequisites has been in use by the authors since 1941. It uses two x-ray tubes at right angles powered by a generator of 1,000 ma. at 100 kv.p. A maximum of 70 special cassettes can be used in each of the two planes. The total irradiation received by the patient does not exceed 10 r for 50 pairs of pictures. This is in contrast to a dose of four to ten times this amount when photofluorography is used. Angiocardiograms are reproduced showing the dynamic functioning of several of the heart chambers in right-angle paired films. Because of the multiplicity of films, cross circulation as well as small defects and their exact localization an be ascertained.

Fifteen roentgenograms; 2 drawings of the apparatus.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Angiocardiographic Confirmation of Pericardial Effusion. Louis Levy, II, Richard Fowler, Harold Jacobs, John Leckert, John Irion, Irving Rosen, and Harold Chastant. Am. Heart J. **43**: 59–66, January 1952.

The authors present the histories of 8 patients in whom x-ray examination revealed an enlarged cardiac silhouette. In 7 of the cases angiocardiography revealed opaque areas outside the limits of the cardiac chambers. Pericardiocentesis in 5 of these cases yielded fluid—pus in 1, straw-colored fluid in 1, serous fluid in 1, and serosanguineous fluid in 2. In the eighth case, the angiocardiogram revealed marked right and left ventricular dilatation with hypertrophy of the right ventricle, and the final diagnosis was acute rheumatic carditis superimposed on chronic rheumatic mitral valvulitis.

The authors admit that the presence of a "considerable shadow outside the limits of the cardiac chambers does not invariably indicate the presence of a pericardial effusion." In 1 case, at autopsy, it proved to be due to an organized, fibrinous pericardial exudate, which did not yield fluid when pericardiocentesis was attempted.

Eight roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

The Value of Photoradiography in Detection of Heart Disease. Follow-up Study of Cardiac Lesions Found in a Mass (70 mm.) X-Ray Survey. Wesley Van Camp and Doris Rowe. Rocky Mountain M. J. **48**: 934–937, December 1951.

In June and July 1947, the Tuberculosis Control Division of the Colorado State Department of Public Health conducted an x-ray survey of 4,079 patients at the Colorado State Hospital, using a 70-mm. mobile unit; 618 patients were not included in the investigation either because they were confined to bed or were too disturbed. In 139 cases the roentgenograms suggested pulmonary disease (active tuberculosis 35, inactive tuberculosis 62, suspicious of tuberculosis 42), and in 101 cases a cardiac lesion. The patients with abnormal cardiac findings were examined in the Cardiac Clinic, electrocardiograms were taken, and 14 × 17-inch chest films were obtained. The great majority of the 85 patients followed were found not only to have "heart trouble" but to be in need of some type of cardiac treatment. Hypertensive cardiovascular disease and arteriosclerotic heart disease, or a combination of the two, accounted for 67 cases. Seventeen patients had no evidence of heart disease and the remaining 17 had less common cardiac lesions.

Six tables.

Chronic Constrictive Pericarditis. I. Some Clinical and Laboratory Observations. II. Electrokymographic Studies and Correlations with Roentgenkymography, Phonocardiography, and Right Ventricular Pressure Curves. Victor A. McKusick. Bull. Johns Hopkins Hosp. **90**: 3–26, January 1952.

In the first of two papers on chronic constrictive pericarditis, the clinical features of 20 cases are presented. In 8 there was adequate evidence for a tuberculous etiology; the other 12 were representative of the majority of cases of constrictive pericarditis, in which evidence of a specific etiology is unobtainable. This does not necessarily indicate, however, that tuberculosis is not the cause in most if not all instances. In one of the author's patients trauma may have been the main etiologic factor in the scarring of the pericardium.

An adventitious sound in early diastole (protodiastolic sound) was audible in at least half the cases in this series. Impaired respiratory function of a type pointing to primary pleuropulmonary disease was present in some cases, outstanding in some. These patients usually have a thickened pleura as seen on x-ray examination, reduced vital capacity, and impaired chest expansion. Five patients were cyanotic at rest and one became cyanotic with even mild upper respiratory infections. Syncopal attacks occurred on at least one occasion in 3 cases during exertion.

Elevation of the filtration fraction was a consistent feature of renal hemodynamics in 7 cases studied by renal clearance technics.

A dilated superior vena cava was an impressive feature of the chest roentgenograms of these patients. Before operation it was present in some degree in all 20 cases of the constrictive syndrome. Calcification was demonstrated roentgenographically in 10 cases. The calcification was always prominent on, or limited to, the diaphragmatic aspect of the heart. Presumably this is due to sedimentation of inflammatory elements which later become calcified. The calcification also tends to be dense in the atrioventricular grooves. The apex is likely to be free of calcification.

Cardiac catheterization was performed in 13 patients. An early diastolic "dip" followed by a diastolic plateau was a consistent feature of the right ventricular pressure curve. All evidence available from these studies is consistent with the view that these recordings represent a *bona fide* cardiodynamic phenomenon.

Angiocardiography was performed in 4 cases. In none was a localized inflow obstruction demonstrated. The positive findings included: (1) dilated superior vena cava in all cases; (2) thickening of the wall of the heart on the right border (right auricle) in 2 cases; (3) close apposition of the opacified right ventricle to the sternum as seen in lateral view, *i.e.*, obliteration of the

retrosternal space, in 3 cases; (4) dilated main pulmonary artery and dilated left auricle in 1 case.

Results of pericardiectomy were in general satisfactory. Of 15 patients who survived operation, 11 attained clinical cures, 3 were improved, and 1 unimproved. Two patients died during operation from ventricular rupture and cardiac standstill, respectively; both were over fifty-five years of age and had very extensive pericardial calcification.

In the second paper the author describes the electrokymographic findings in the above 20 cases of chronic constrictive pericarditis and correlates these with the roentgenkymographic and phonocardiographic findings, and the right ventricular pressure curves. Of the 20 cases, 5 were studied only preoperatively, 7 both before and after operation, and 8 at least once one to nine years following pericardiectomy.

The characteristic electrokymographic change of constrictive pericarditis is found in the ventricular border tracings and consists of a simplified pattern of "flat-tops and V's," the two limbs of the "V" representing systolic ejection and ventricular filling respectively, and the "flat-tops" representing diastolic standstill. The characteristic "flat-top and V" pattern may not be demonstrable under two circumstances: tachycardia and concealment of the lower ventricular borders by left pleural effusion and/or high left diaphragm due to ascites. A heart rate of more than about 120 will cause a fusion of the "V's" and obliteration of the diastolic plateau. The typical pattern may be suspected, however, from the presence of a steep filling limb and a V bottom. The typical pattern is always most prominent over the lower borders of the ventricles. Pleural effusions or a high diaphragm are likely to make it difficult or impossible to study the complete ventricular silhouette.

In the differential electrokymographic diagnosis, bradycardia, as in complete heart block, is the principal condition which can produce "flat-tops and V's" simulating those of constrictive pericarditis. Bradycardia, however, produces a filling limb less steep than the emptying limb. Furthermore, there are likely to be secondary waves in bradycardia and none in constrictive pericarditis.

A very close correlation was found between the electrokymograms and roentgenkymograms. Since electrokymography as used in these studies provides no means for accurate calibration of border excursion, one must rely on roentgenkymographs for information as to absolute amplitude of border movement and on the electrokymograms for demonstration of diagnostic changes in the pattern of border movement. However, more often than not the roentgenkymograms also show the "flat-top and V" pattern. For greatest success in demonstrating this pattern, the kymograms should be taken in right and left anterior oblique positions as well as in the conventional postero-anterior projection.

Normal patterns of ventricular border movement were found electrokymographically and roentgenkymographically in 3 cases of clinically asymptomatic pericardial calcification.

The early diastolic "dip" of the right ventricular pressure curve occurs during the rapid filling phase.

The protodiastolic sound of constrictive pericarditis is produced by rapid ventricular filling and abrupt halt in filling.

Thirteen illustrations.

Constrictive Pericarditis. William Evans and Frederic Jackson. Brit. Heart J. **14**: 53–69, January 1952.

In an analysis of 30 patients in the Cardiac Department of the London Hospital who had undergone surgery for constrictive pericarditis, the authors show evidence to support the view that the disease is the outcome of a tuberculous infection.

The earliest and commonest complaint was found to be breathlessness on exertion. Fullness and swelling of the abdomen caused by a distended liver and ascites were present in two-thirds of the patients, and ankle edema, left chest pain, swelling of the face, fatigue, and cough were other symptoms.

Many of the objective signs of constrictive pericarditis are found in patients with right-sided heart failure, and the authors give a thorough discussion of the differential diagnosis.

Roentgenographically, some or all of the following changes were found in the authors' 30 cases: slight or moderate enlargement of the cardiac silhouette, prominence of the right border, filling of the cardiovascular angle on the right side, calcification, absence of pulmonary congestion, and prominence of the left auricular impression in the right oblique view with barium in the esophagus. This last change differed from that met with in mitral stenosis in that between the barium stream and the heart shadow there was a relatively clear area. Calcification of the pericardium was present in two-thirds of the cases; this sign, so valuable in diagnosis, is to be sought in three special places. During fluoroscopy in the anterior position, it is seen end-on as a strip along the left ventricular border and/or mesially below the heart, which it appears to support saucer-like; in the left anterior oblique view the calcium line shows to even better advantage and may be likened to a cup holding the heart.

Most of the patients receive relief from cardiac decompression and denuding of the thick pericardium from the ventricles, especially if this procedure is carried out before the onset of cirrhosis.

Eight roentgenograms; 2 photomicrographs; 6 electrocardiograms; 1 table. FRANK T. MORAN, M.D.
Auburn, N. Y.

Chronic Cardiac Compression (Chronic Constrictive Pericarditis). A Critical Study of 61 Operated Cases with Follow-up. J. R. Chambliss, E. J. Jaruszewski, B. L. Brofman, J. F. Martin, and H. Feil. Circulation **4**: 816–835, December 1951.

The authors report what they believe to be the largest operative series of chronic constrictive pericarditis on record: pericardiectomy was done in 61 patients 69 times, with an operative mortality of 18 per cent and a satisfactory result in 72 per cent. The series comes from the service of Dr. C. S. Beck of the University Hospitals of Cleveland, Ohio.

The contraction of the pericardial scar (usually extensive but sometimes fairly localized) causes interference with diastolic filling of the heart and thus reduces the cardiac output. The characteristic picture consists of the triad of high venous pressure, ascites, and a small quiet heart. Dyspnea and fatigue are usual symptoms.

Of the 61 cases, 28 per cent were of tuberculous origin. In most of the others the etiology was unknown. Two were pyogenic, 3 followed acute nonspecific pericarditis, and 1 was considered possibly of rheumatic origin.

The roentgen aspect of the study consisted in a review of the roentgenographic and fluoroscopic observations in 58 cases. The heart was enlarged in 28 cases. Calcification, identified in 27 patients, was frequently extensive. Roentgenoscopic observations and kymograms revealed a decrease in the amplitude of the pulsations in every instance. With a change in the position of the patient, fixation of the heart caused a diminished lateral shift in 33 of the 40 cases so studied. In these there was no respiratory change in contour. The behavior of the diaphragm during respiration was variable, with decrease in excursion or with portions appearing fixed. In a small number of patients, a paradoxical movement was observed.

Postoperative roentgen studies were obtained in 45 patients. Improvement in the amplitude of pulsations occurred in 41. In some, it was localized to the area where the scar was removed, in others, generalized. The heart size was unchanged in 18 patients, increased in 16, and decreased in 11. The pericardial calcification was not completely removed in many patients and was identified in 21 in the postoperative roentgenograms.

The authors' analysis is very complete, covering all phases of the subject. Those interested should read the original paper for the numerous data presented on this large series of cases.

Six roentgenograms; 3 electrocardiograms; 3 photomicrographs; 1 table, summarizing the results of pericardiectomy as reported in the literature.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Clinical and Cardiac Catheterization Findings Compatible with Ebstein's Anomaly of the Tricuspid Valve. Report of Two Cases. B. van Lingen, M. McGregor, J. Kaye, M. J. Meyer, H. D. Jacobs, J. L. Braudo, T. H. Bothwell, and G. A. Elliott. Am. Heart J. **43**: 77–88, January 1952.

Ebstein's anomaly of the tricuspid valve is a rare congenital anomaly in which the tricuspid valve is displaced downward and divides the right ventricle into two parts, so that the proximal portion is continuous with the cavity of the right auricle. This portion of the right ventricle enlarges because of the incompetency of the valve and inability to empty completely. No cases of the anomaly have been diagnosed during life.

The authors considered the diagnosis of Ebstein's anomaly in 2 cases because of interesting results obtained from clinical studies, including cardiac catheterization (no autopsy confirmation).

The resemblance of the radiological findings in these 2 cases and in those described by Engle and associates (Circulation **1**: 1246, 1950. Abst. in Radiology **56**: 766, 1951) is striking. The outstanding feature in the postero-anterior view was enlargement of the heart, predominantly to the left, with a fullness of the cardiac silhouette immediately below a concave pulmonary artery segment. This results in a square-shaped heart. The anterior heart border was flattened against the chest wall in both oblique views, and in the right anterior oblique view there was a prominence of the outflow portion of the right ventricle. The pulmonary arteries were normal or diminished in size.

The pulsations of the heart borders in the postero-anterior view were poor, whereas those of the left ventricle in the left anterior oblique view were normal. It is concluded that the right ventricle must form the left heart border in the postero-anterior view, and this was confirmed during cardiac catheterization. That the right ventricle is tremendously enlarged is suggested by these findings and the apposition of the anterior heart border to the chest wall in the oblique views. The radiological findings would appear to be the result of the dilatation of the congenitally thin right ventricular wall.

Electrocardiograms, jugular phlebograms, phonocardiograms, and other illustrations are included. Two tables give the pressures and oxygen content findings obtained during cardiac catheterization. A discussion is also included, justifying the diagnosis.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Glycogen Disease. Report of Two Cases with Cardiomegaly. James F. Martin and Frederick J. Bonte. Am. J. Roentgenol. **66**: 922–928, December 1951.

Glycogen disease, first recognized by von Gierke in 1929, is a condition in which large amounts of glycogen are deposited in the liver, heart, kidneys, striated muscle, adrenals, and in almost all the other body tissues except integument and bone. The etiology is unknown but a familial factor has been suggested. The onset is usually between the ages of four and twelve months.

A clinical classification includes four types, involving, respectively, (1) the liver and kidneys; (2) liver, heart, and skeletal muscle with no kidney involvement; (3) heart, with possibly slight liver involvement; (4) heart, tongue, skeletal and smooth muscle.

Clinical laboratory findings of significance are ketonuria without glycosuria, asymptomatic hypoglycemia, flat glucose tolerance curves, and minimal or no elevation of blood sugar following parenteral administration of epinephrine.

The physical findings include enlargement of the liver, heart, or kidneys. Splenomegaly is not present. In the cardiac type of the disease, the physical findings are related to cardiac insufficiency with edema and cyanosis or to the respiratory system, where various degrees of distress may be observed.

Roentgen studies are of value in demonstrating the cardiac enlargement and its effect on adjacent organs. In some instances, the cardiac contour is sufficiently characteristic to lead to a tentative diagnosis of congenital heart disease. The use of angiocardiography has been of great value in excluding congenital developmental defects. The final differential diagnosis must rest upon the demonstration of an increased glycogen content in the skeletal muscle obtained at biopsy or upon the chance finding of evidence of some abnormality in the carbohydrate metabolism.

Two cases are reported.

Two roentgenograms; 2 tables.

I. EARL HOLMES, M.D.
University of Louisville

Cor Pulmonale Resulting from Pulmonary Arteriolosclerosis. Report of a Case. Josephine S. Wells and Philip Brown. Am. J. Roentgenol. **66**: 894–899, December 1951.

The authors present the case history of a 34-year-old woman who died of heart failure with cor pulmonale. A normal chest film had been obtained six years prior

to the onset of dyspnea and edema. Serial films then showed progressive increase of the pulmonary artery segment on the left and a general increase in the heart size. The lung fields remained clear throughout the illness. Autopsy findings revealed no primary cardiac abnormality except for right-sided enlargement. The pulmonary arterioles showed hypertrophy of the muscle wall with some narrowing of the lumina. This did not seem extensive enough to account for the cardiac changes and some functional changes were postulated. The differential diagnosis of cor pulmonale is discussed.

Five figures. LAWRENCE A. DAVIS, M.D.
University of Louisville

Ventricular Aneurysm. A Case of More than Twelve Years' Duration. Hugh H. Hanson and Harry L. Smith. Minnesota Med. **34:** 1177–1180, December 1951.

Ventricular aneurysm is more common in males than in females. It occurs during the years when coronary heart disease is more prevalent, and is actually a manifestation of that disease in a high percentage of cases. As a complication of myocardial infarction the incidence has been reported as approximately 10 per cent, the aneurysms occurring after an interval ranging from one week to months following the acute episode. The aneurysms most frequently occur on the anterior apical aspect of the left ventricle and are usually single.

In the case reported here, there was no specific history of infarction, but the patient, a 55-year-old male, gave a history of angina pectoris in 1937. One year later he was hospitalized for cardiac insufficiency. In 1939 the diagnosis of aneurysm was made by roentgenologic examination. For ten years, 1941 to 1951, the patient remained relatively asymptomatic. Decompensation occurred in the latter year and a chest roentgenogram of 1951 showed the cardiac contour to be similar to that of 1939. A large well defined bulge projected to the left in the region of the left ventricle. Fluoroscopically this showed expansile pulsations. The patient was discharged to his home in 1951 on a restricted cardiac regime.

The diagnosis of ventricular aneurysm may be difficult to make at necropsy. It is based mainly on roentgenologic findings. The principal feature is a bulge in the contour of the left ventricle. Helpful criteria are myocardial angulations, incisura and abnormal pulsations, evidence of a thrombus, and pericardial adhesions. Paradoxical pulsations, if present, are practically pathognomonic. Roentgenkymography and angiocardiography are mentioned as helpful, but these procedures are not discussed.

Two roentgenograms. D. D. ROSENFELD, M.D.
Fontana, California

Contribution to the Knowledge of Dissecting Aneurysm of the Coronary Artery. H. J. Schmid. Schweiz. med. Wchnschr. **81:** 1170–1172, Dec. 1, 1951. (In German)

A rounded faintly calcified structure was discovered on chest roentgenograms of a 38-year-old man who did heavy manual labor and was apparently healthy except for recurrent attacks of asthma and chronic pulmonary emphysema. The x-ray appearance of this mass, which merged with the left heart border, remained unchanged over nine years. Fluoroscopy was non-conclusive. The patient continued to do physically heavy work until a few weeks before his death, which occurred at the age of forty-seven years and was caused by an acute exacerbation of asthma.

Autopsy revealed, in addition to emphysema and bronchiectasis, an apparently old dissecting aneurysm of the ramus intermedius of the left coronary artery, which was completely occluded by and filled with fibrillar and hyaline connective tissue containing partially ossified calcium deposits. The myocardium was not affected.

According to the author, this is the thirty-ninth case of this condition described in the literature and the largest coronary artery aneurysm on record (diameter 11 cm.).

One roentgenogram; 2 photographs.
GERHART S. SCHWARZ, M.D.
New York, N. Y.

Dextrocardia Secondary to Foreign Body in Left Bronchus. Report of Two Cases. Murdock Equen, Frank Buckner, George Roach, and Robert Brown. South. M. J. **45:** 16–18, January 1952.

The authors present 2 cases of foreign bodies in the left main bronchus in children of fifteen and fourteen months. The offending foreign bodies were a piece of bone in one case and a "sandspur" in the other. In each instance a ball-valve obstruction was produced and emphysema was demonstrable on the affected side, with shift of the mediastinum away from the site of obstruction.

In cases of radiotranslucent foreign body producing suspected obstructive emphysema, the advisability of taking films both in inspiration and expiration is pointed out. On inspiration the leaf of the diaphragm on the unobstructed side will be lowered and the mediastinal contents will tend to shift to the midline. On expiration, however, the bronchial walls around the obstruction will collapse and prevent the expulsion of air distal to the foreign body; consequently, while the leaf of the diaphragm on the unobstructed side ascends, the leaf on the side of the obstruction remains where it was, and the mediastinum shifts towards the unaffected side.

Two roentgenograms.
T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Complete Transposition of the Great Vessels. Roy Astley and Clifford Parsons. Brit. Heart J. **14:** 13–24, January 1952.

In complete transposition of the great vessels the relative positions of the aorta and pulmonary artery are reversed. Of 300 children seen with congenital heart disease at the Birmingham (England) Children's Hospital in eighteen months, 72 had cyanosis, and of this number 16 had complete transposition of the great vessels. On the basis of this series, it is pointed out that the diagnosis should be strongly suggested if any of the following three features are present: (1) a narrow vascular pedicle, (2) a long bulge in the left middle segment of the cardiac outline, and (3) a concave left middle segment. Pulmonary plethora occurring when there is no concave left middle segment, and neither of the first two signs is present, is also suggestive, though not pathognomonic since it has been found to occur in other cyanotic conditions such as persistent truncus arteriosus.

The differential diagnosis from tetralogy of Fallot is

of considerable importance. It may be easy if the lungs are congested, but is difficult in the presence of normal or decreased pulmonary vascularity.

The authors used angiocardiography to confirm the diagnosis in 6 children. In 2 of these the aorta arose near the midline and arched normally, while in 4 the aorta lay further to the left, in the position normally occupied by the main pulmonary artery. Angiocardiography has been found more valuable in small, cyanotic children than catheterization, but the latter may help to distinguish the nature of associated defects.

In transposition, the first objective of operation should be to increase the oxygen supply to the coronary arteries. The treatment, therefore, varies with the different types of shunt. Although transfer of the great arterial trunks is at present impossible, operation to transpose the great veins is suggested as a future surgical goal.

Seven roentgenograms; 3 drawings; 3 tables.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Right Aortic Arch: Radiologic Aspects of Principal Variations. M. Brombart and M. Segers. J. belge de radiol. **35:** 55–94, 1952. (In French)

Isolated right aortic arch (not associated with congenital cardiac malformation) is rare and often not recognized because of the paucity of subjective symptoms. Occasionally dysphagia lusoria is associated with the anomaly. Eleven cases found in a series of 8,000 roentgen examinations with opacified esophagus are presented.

In this anomaly the aortic arch develops from the fourth branchial arch on the right instead of on the left. The left subclavian artery may arise as the first great vessel from the arch and cross anteriorly to the trachea, or it may arise as the last great vessel and cross the posterior wall of the esophagus. In the latter event, the subclavian artery arises from a diverticulum, the remnant of the fourth left branchial arch.

From the roentgenologic point of view three types of right aortic arch are distinguished: (1) simple right aortic arch; (2) right aortic arch with posterior diverticulum; (3) the "surrounding" type, in which the aorta crosses to the left behind the esophagus to descend on the left. Type 2 is the most frequent.

The right aortic arch behaves in the usual manner in regard to sclerosis, syphilis, and hypertension. There are often associated anomalies of veins, ribs, or dorsal vertebrae. One case was associated with a left azygos pulmonary lobe.

Twenty-three roentgenograms; 24 drawings; 1 table.

CHARLES M. NICE, M.D.
University of Minnesota

THE DIGESTIVE SYSTEM

The Radiologist and Epigastric Pain. A. E. Broome. Canad. M. A. J. **65:** 569–571, December 1951.

Advances in radiography and improvement of contrast media have recently increased the diagnostic accuracy of abdominal radiology. Nevertheless, there are abnormalities of many types which cannot be recorded on films and require careful fluoroscopic study. Interpretation of radiologic findings must be determined both by abnormalities of tissue structure and of function. The author believes that at least half of the patients referred for x-ray investigation of the gastrointestinal tract and in whom the more obvious lesions cannot be visualized will have demonstrable abnormalities of function. These are chiefly aperistalsis, hyperperistalsis, dilatation of the lumen, spastic contractions of the lumen, and marked variations of motility of the test meal. Tenderness on abdominal palpation under fluoroscopic vision is in the referred areas of pain of visceral origin.

Endoscopy has shown that cardiospasm is more common than previously suspected. The early findings may be difficult to demonstrate, since there may be minimal esophageal dilatation which may easily be missed on fluoroscopy. Unusual delay in transit of the meal with even questionable dilatation of the esophagus, when neoplasm, varices and ulcer can be ruled out, must be considered as cardiospasm.

Hiatal hernias should be examined for spontaneous reduction and proved to be either sliding or incarcerated.

Air swallowers can be identified and helped by giving them insight into their condition.

Gastrospasm in the rapidly emptying stomach which seems to fill completely with 4 to 6 ounces of barium mixture, and in which the mucosal folds are heavy and close together, is considered to be indicative of gastritis.

Spasm of the pyloric segment is difficult to assess. Peristalsis is interrupted and the mucosal pattern is compressed but not grossly deformed. Delay in emptying is minimal. The gastric profile may suggest new growth, but localized pain is present which is held to be in favor of spasm. Palpation helps to rule out tumor.

Endoscopy or exploration may be necessary to differentiate between antral gastritis and early prepyloric new growth.

Upper abdominal discomfort is seen in a large group of cases in which abnormalities of the colon are later found. These include abnormalities of the appendix or cecum, diverticula of the transverse colon or sigmoid, and rectal changes sometimes seen with fissure or thrombosed hemorrhoids.

MASON WHITMORE, M.D.
Jefferson Medical College

Modifiers of Digestive Behavior Introduced Electrically. L. Constantin. Radiol. clin. **21:** 33–45, January 1952. (In French)

The effect of choline salts on the digestive tract, when applied by electrical means, is described. Specifically, in this study acetyl-beta-methylcholine bromide was used. Barium mixture, sometimes containing 40 drops of dihydro-ergotamine solution (actual dosage not given) is administered by mouth. An electrode apparatus similar to that previously used in iontophoresis treatment of leg ulcer or arthritis is used. The electrodes are applied externally, preferably avoiding thick soft tissue and bony parts. An ampule of the choline salt is applied to the positive electrode, which is placed near the region studied. A vagotonic effect occurs, with hypertonia and increased peristaltic movement of the stomach and small and large bowel. It is postulated that this might enhance roentgenographic demonstration of lesions near the pylorus, small bowel lesions, diseases near the ileocecal valve, and colonic lesions in which a hypotonia or decreased peristalsis frustrates the observer. It is possible, also, that the method may be used as a therapeutic adjunct where such physiologic conditions prevail.

Eight roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

Fish Bones in the Esophagus. Joseph L. Goldman. Ann. Otol., Rhin. & Laryng. **60:** 957–973, December 1951.

This study was undertaken to determine whether fish bones in the esophagus are or are not as frequently translucent roentgenologically as is commonly believed. It is based on an analysis of a series of cases in a general hospital (Mount Sinai, New York) as well as a roentgenologic study of fish bones in a phantom closely simulating the tissue density of the neck and superior mediastinum.

The hospital records comprised 185 cases of foreign bodies in the esophagus collected over a period of fifteen years. Of the 185 patients, 56 were suspected of harboring a fish bone in the esophagus. The outstanding symptom in 36 patients was persistent pain in the neck, located laterally or in the area of the suprasternal notch. Thirty patients suffered from varying degrees of dysphagia. In several instances, complete inability to swallow was noted.

In 40 of the 56 patients a fish bone was demonstrated at esophagoscopy or operation. The fish bone was found at the cricopharyngeus or within 2 cm. below the cricopharyngeus in 17 cases. In 22 other patients, it was located in the upper esophagus above the thoracic inlet.

Roentgen or direct evidence of a fish bone was obtained in 30 instances. In 21 cases, x-ray studies revealed varying degrees of prevertebral widening. Correlation of this feature with clinical complications, such as periesophageal abscess or mediastinitis, showed that gas was usually encountered when a complication existed. In only 1 of 12 cases with widening alone was a complication found, while in all 9 cases in which gas was also present complications existed. Of the 56 patients with symptoms after ingestion of fish, 10 (18 per cent) had serious complications resulting from injury caused by the bones: 4 had periesophageal abscess, 3 mediastinitis, 3 perforation of the esophagus.

Rib bones of varying thickness and size were removed from 21 different types of fish and studied roentgenographically. Technic played a significant role in these experimental studies. The best results were obtained by employing a short exposure (1/20–1/10 sec.), with small coning, small focal spot, and an x-ray negative slightly on the dark side. Occasionally fish bones may not lie in a true coronal plane but are placed in an oblique one. Accordingly, it may be worth while to obtain films in slightly oblique positions.

In obtaining the history from a patient who has swallowed a fish bone, the kind of fish ingested should be noted. Fish bones whose radiopacity can be expected to be of diagnostic value are those of bass, codfish, flounder, fluke, gray sole, haddock, halibut, porgie, red snapper, sea bass, smelt, striped bass, and white perch. Bones of salmon and yellow pike are radiopaque to a lesser degree, while those of bluefish, butterfish, mackerel, pompano, and trout produce faint or no opacity.

Eleven roentgenograms; 2 photographs; 7 tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Pharyngeal Diverticulum: Report of a Large Diverticulum Causing Complete Obstruction to the Oesophagus. Thomas F. Rose. M. J. Australia **2:** 776–779, Dec. 8, 1951.

A case of pharyngeal diverticulum (pharyngo-esophageal diverticulum) in a 69-year-old man is reported. The patient was admitted to the hospital with a history of increasing difficulty in swallowing for the past ten years. For the three weeks previous to his admission he had been unable to swallow any solids and in the last week he could not even swallow fluids. He was 6 feet 6 inches tall and normally weighed around 224 pounds. During the past three years his weight had fallen to 149 pounds. X-ray examination showed that the entire barium meal went into a large pharyngeal diverticulum. At four hours there was only a faint trace of barium in the esophagus and none in the stomach. The diverticulum was very large and was growing into the superior mediastinum and compressing the esophagus. At twenty-four hours there was no barium in the esophagus, stomach, or intestine, the diverticulum being still filled. The patient was so starved and dehydrated that for two weeks he was fed through a Wangensteen tube. At the end of that time his condition had improved sufficiently to permit operation. A diverticulum measuring 7.5 × 7.5 × 5 cm. was found and removed. Following the operation the patient had no symptoms of dysphagia.

Four roentgenograms; 1 photograph.

Results of Medical Treatment of Idiopathic Cardiospasm. Armistead C. Crump, Charles A. Flood, and George C. Hennig. Gastroenterology **20:** 30–38, January 1952.

Idiopathic cardiospasm, or achalasia, is a disorder in which there is a persistent tonic contraction of the esophagus from the level of the diaphragm to the stomach, commonly associated with defective tone and peristalsis in the main part of the esophagus above the area of constriction.

The records of 72 patients treated by forceful divulsion of the cardia were reviewed. This divulsion was accomplished in most cases by means of a metal dilator of the Starck type first introduced into the stomach and then retracted to the cardia, with the blades opened against the "tight esophageal muscle." In a few instances the dilation was performed with an air-bag. Satisfactory relief of symptoms was obtained in 59 patients after one attempt. Only 3 patients failed to gain relief after the third treatment.

Follow-up roentgenologic examination showed the esophagus to remain abnormal in appearance up to nine years following divulsion. In those patients who had been relieved by treatment, barium passed readily into the stomach in the erect position. A continuous stream of barium was observed to pass through the lower esophageal segment in contrast to interrupted spurts of barium noted before divulsion. The degree of dilatation of the esophagus appeared less marked than before treatment. Peristaltic waves were either not observed or were ineffectual. From the roentgenologist's point of view the picture was still that of cardiospasm. Reexamination roentgenologically of those patients who were unrelieved by treatment showed essentially no change in comparison with previous examinations.

I. R. BERGER, M.D.
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Difficulties in the Diagnosis of Certain Gastric Lesions. Joseph C. Bell. South. M. J. **45:** 3–5, January 1952.

In addition to a careful history, physical examination, and certain laboratory tests, special consideration

should be given to gastroscopic and x-ray examinations in the diagnosis of gastric disease. These two procedures are supplementary rather than competitive.

The mucosa of a large part of the stomach can be seen by gastroscopy, and lesions manifested in the mucosa can be observed directly. Some lesions, however, do not involve the mucosa, as for example certain carcinomas that spread beneath it, and there are, also, "blind spots" that cannot be visualized gastroscopically.

Roentgen examination is the most widely used method in investigating gastric lesions and is highly accurate. Fluoroscopic examination and good film coverage are stressed. These are important in evaluation of flexibility of the stomach wall, since most early malignant tumors invade the musculature with resultant loss of intrinsic movements. Carcinoma of the fundus may be outlined by air contrast in the stomach bubble. Moderate dilatation of the distal esophagus may be present in carcinoma in this location. A tumor near the esophageal orifice may cause a cascade-like fall of barium entering the stomach.

Ulcers of the fundus and some of the posterior gastric wall may be missed radiologically but demonstrated by gastroscopy, although the gastroscope is of less help in lesions of the fundus.

Gastroscopy is the method of choice in examination for gastritis. Fluoroscopy and serial films with reexamination when indicated are helpful in determining the presence of a constant deformity or loss of movement, in differentiating between gastritis and a malignant growth. Loss of flexibility and intrinsic movement is sometimes seen in gastric syphilis. In this event, serological tests may be helpful for differentiation.

Certain bezoars may produce constant filling defects radiologically. Chronic ulcers, usually benign, may be difficult or impossible to detect. Diaphragmatic hernias are common and seldom offer difficulty in diagnosis.

MASON WHITMORE, M.D.
Jefferson Medical College

Premalignant Lesions of the Gastrointestinal Tract. I. The Significance of Roentgenologic Evidence of Hypertrophic Gastritis. Robert P. Barden. Am. J. Roentgenol. **66**: 915–921, December 1951.

This excellent article discusses the relationship between chronic hypertrophic gastritis and carcinoma of the stomach. Several case reports are given. The conclusions reached are: (1) that chronic hypertrophic gastritis and carcinoma of the stomach may be indistinguishable roentgenologically and that, in both, the appearance of the stomach is abnormal; (2) that, in an unpredictable number of patients with hypertrophic gastritis, carcinoma will eventually develop; (3) that changes attributed to chronic hypertrophic gastritis may exist unchanged roentgenologically for years.

Although gastroscopic and pathologic studies in gastritis indicate that there are several different types which may be recognized (atrophic, superficial, hypertrophic, phlegmonous, etc.), these distinctions cannot be made by the roentgenological examination. It seems best to limit the roentgen diagnosis to a condition in which one can demonstrate definitely or markedly enlarged and irregular rugal folds throughout the stomach or localized to a portion of it. The finding of "stiffness" or lack of change in these folds may indicate extensive infiltration by inflammatory elements as opposed to edema alone, but this quality of stiffness is difficult to demonstrate adequately unless it is a very marked feature and should not be considered an essential characteristic of the roentgenologic picture.

When carcinoma develops in association with chronic hypertrophic gastritis, it may spread extensively throughout the submucosa of the stomach without producing ulceration or a projecting tumor. In this silent and insidious manner, the entire stomach may be permeated before the symptoms or roentgen signs of definite carcinoma appear. It is this spread of carcinoma without additional concomitant change in form or function of the stomach which makes its detection by roentgenologic and gastroscopic means exceedingly difficult or impossible.

In view of these observations, it is felt that prophylactic resection of the stomach of all patients with roentgen evidence of gastritis should at least be considered.

Five roentgenograms.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Gastric Displacement by Extrinsic Tumors: Analysis of 132 Cases. Carlo Cuccia. Radiol. med. (Milan) **37**: 969–986, December 1951. (In Italian)

The author reports on 132 cases of proved abdominal tumors extrinsic to the gastro-intestinal tract and the displacement of the stomach caused by these tumors. His material is condensed in the following table.

GASTRIC DISPLACEMENT BY EXTRINSIC TUMORS

	Number of Patients	Gastric Displacement				
		Anterior	Posterior	Left	Right	Upward
Node enlargement	72	72		40		12
Pancreas						
Head	4	4		4		
Body	2	2				1
Tail	2				1	
Spleen	13	2	1		11	
Left kidney	3	2			2	
Liver						
Right lobe	3		1	3		
Left lobe	21			14		
Anterior abdominal wall	3		1	1		1
Gastrohepatic ligament	1		1	1		
Aneurysm of abdominal aorta	1			1		
Left retroperitoneal tumor	4	4			4	
Ovary	3					3

The article is well written, the cases are analyzed with judgment and care, and the illustrations are excellent. The writer, by presenting such a comprehensive study of abdominal tumors, succeeds in giving a workable idea of the incidence of such tumors and of their most common behavior with regard to the stomach.

Twenty-five roentgenograms; 2 tables.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Detection of Gastric Carcinoma by Photofluorographic Methods. Part III. Findings. John F. Roach, Robert D. Sloan, and Russell H. Morgan. Am. J. Roentgenol. **67**: 68–75, January 1952.

In this paper the authors present the findings of a study conducted at Johns Hopkins Hospital whereby routine photofluorographic gastro-intestinal examinations were obtained on all dispensary patients, regardless of symptoms, in an attempt to evaluate the efficacy of this procedure in disclosing gastric pathology, and its practicability. The indications for the study and the equipment employed have been previously described (Am. J. Roentgenol. **61**: 183, 188, 1949. Abst. in Radiology **54**: 140, 1950).

Ten thousand examinations were done on persons forty years of age and above. A 2-ounce barium sulfate solution was given, and anteroposterior and two right anterior oblique exposures were made. Four more ounces of the same solution were then given, and a postero-anterior and two right anterior oblique films were obtained.

The stomach was considered abnormal in 9.4 per cent of the cases in which satisfactory films were obtained. The duodenal cap was considered abnormal in 2.2 per cent and normal in 50.0 per cent. There was inadequate filling of the bulb for evaluation in the remaining group. Standard gastro-intestinal series were also done in 1,209 of the patients for purposes of comparison. Of those patients studied by both methods, 60.6 per cent were interpreted as normal on both, 10.4 per cent abnormal on both, 25.4 per cent abnormal on the miniature films but normal on the standard series, and 1.4 per cent normal on the miniature but abnormal on the regular series. A total of 126 patients had abnormal findings on both examinations; 27 of these proved to have gastric carcinoma, 27 had unproved but potential cancer; in 20 cancer was suspected but disproved, while a remaining 52 patients had unproved but potentially benign lesions. The majority of the group with proved cancer were symptomatic, and the clinical course in these cases was that of most patients with inadequate surgical extirpation due to extension of the lesions beyond the confines of the stomach.

It is felt that the photofluorographic method is sufficiently accurate in the detection of disease and is thus applicable as a survey method for studying the upper gastro-intestinal tract. The yield, however, in the demonstration of asymptomatic gastric cancers is so low (0.2 per cent in this series) that it does not seem a feasible solution for reduction of the mortality of malignant gastric lesions.

J. W. WILSON, M.D.
Indiana University

Colonic Replacement of the Stomach: Early Results of Radiological Investigation. B. B. Harrison. Lancet **1**: 25–28, Jan. 5, 1952.

Partial gastrectomy, as at present practised, consists in removal of up to three-quarters of the stomach, with subsequent anastomosis of the gastric remnant to the jejunum several inches beyond the duodenojejunal flexure. This procedure inevitably interferes with the normal physiology of the gastro-intestinal tract, and as many as seven types of early postcibal syndrome, attributed to loss of the stomach reservoir or to overloading of the upper small bowel, have been described (Wells and Welbourn: Brit. M. J. **1**: 546, 1951). To overcome the deficiencies of the Polya type of gastrectomy, Moroney (Lancet **1**: 993, 1951) substituted a length of transverse colon for the resected portion of the stomach. This was intended to increase the capacity of the "gastric" reservoir and to insure that chyme entered the small bowel in the normal manner. The author has followed radiologically for six months or more 30 cases treated by colonic replacement of the stomach, with particular reference to the physiological aims of the operation. The findings are described in considerable detail.

A "stomach mechanism" is produced which has a capacity at least twice that of the gastric remnant after a Polya gastrectomy, and possibly nearly two-thirds that of a normal stomach. The colonic segment regurgitates the meal frequently into the stomach remnant, insuring some degree of mixing and maceration of food.

Chyme enters the small bowel intermittently and by the normal route. Thus, the essential intimate contact between intestinal contents and intestinal mucosa is maintained.

Passage of the meal through the small bowel may be somewhat slower than before operation, the meal normally reaching the ascending colon six hours after ingestion.

The site of resection of the colonic segment is not identifiable after operation, but the level of the hepatic flexure is always lowered.

Although early results have been encouraging, further clinical and physiological studies will be necessary before the value of the operation can be finally assessed.

Nine roentgenograms; 1 drawing.

Complications of Gastrointestinal Diverticula Demonstrated by X-Ray. Ernest A. Mendelsohn. Gastroenterology **20**: 105–118, January 1952.

Eight cases of diverticulum of the gastro-intestinal tract are reviewed. In each instance the diverticulum was the source of severe gastro-intestinal symptoms, and the condition was demonstrated roentgenologically.

Case I: An 82-year-old white female had progressive dysphagia, with inability to ingest solid food. Roentgenologic examination revealed barium entering a large pouch located posteriorly and to the left of the esophagus. This pouch was just below the pharynx and extended into the superior mediastinum. The esophagus was greatly compressed and displaced at the level of the diverticulum. Excision of the diverticulum was followed by relief of symptoms.

Case II: A 43-year-old man had a large diverticulum arising from the posterior wall of the fundus of the stomach. The patient complained of gastric burning for four years. With medical treatment the symptoms subsided. [Similar results are obtained at times in patients with shallow peptic ulcerations not identified roentgenographically.—I.R.B.]

Case III: A 70-year-old physician complained of epigastric pain and multiple tarry stools. Roentgen examination revealed normal findings in the stomach

and duodenal bulb. A large duodenal diverticulum was noted originating from the lower duodenal knee. Close to the tip of the diverticulum a deep ulcer niche could be demonstrated. On an ulcer regime, symptoms and roentgen evidence of ulcer subsided.

Case IV: A 55-year-old white woman, complaining of nausea and vomiting, gave a history of cholecystectomy fifteen years earlier. Two irregular duodenal diverticula were discovered on x-ray examination and at surgery one of these was found to be bound down to the common duct. The diverticulum was freed and removed and the patient became asymptomatic.

Case V: A 3-year-old child had abdominal cramps and bright red blood in the stools. Roentgen examination demonstrated a Meckel's diverticulum. Ten days later, the child went into shock and at operation a perforated ulcer was found at the base of the diverticulum. Microscopically, gastric and gallbladder mucosa were seen at the base of the diverticulum.

Case VI: A 68-year-old woman had a duodenocolic fistula apparently arising in a diverticulum of either the duodenum or colon. Symptoms included abdominal cramping, diarrhea, and a fetid odor to the breath. Excision of the fistula produced a cure.

Case VII: A 52-year-old dentist experienced sudden, acute, severe pain in the abdomen accompanied by nausea and vomiting. A barium enema study disclosed multiple sigmoid diverticula and a pool of barium apart from the sigmoid. This was interpreted as indicating perforation, with abscess, of one of the sigmoid diverticula. Under medical management the abscess resolved.

Case VIII: A 67-year-old white man with bright red rectal bleeding was found to have a large sigmoid papilloma associated with diverticulosis.

Nine roentgenograms. I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Roentgen Diagnosis of Prolapse of the Gastric Mucosa into the Duodenum. Maurice Feldman and Philip Myers. Gastroenterology **20:** 90–99, January 1952.

The reported incidence of prolapse of gastric mucosa as determined roentgenologically varies widely. The authors found an incidence of 14 per cent in an analysis of 371 consecutive roentgen examinations. This relatively high incidence is thought to be due in part to the fact that all of these patients had stomach complaints, and many had duodenal ulceration.

Redundant mucosa, gastritis, and increased gastric peristalsis are considered to be the three chief etiologic factors. The last named factor is frequently found in association with duodenal ulceration and hence the two conditions are often co-existent. On the other hand, hypomotility and hypoperistalsis usually seen with gastric ulcer may explain why gastric ulcer and gastric mucosal prolapse are infrequently found together. In the authors' series of 52 cases of prolapse of the gastric mucosa, duodenal ulcer was found in 38.5 per cent, gastritis in 46 per cent, gastric ulcer in 5.8 per cent.

The following roentgenographic findings are, in general, characteristic of prolapse of the gastric mucosa into the duodenal bulb: (1) a defect in the base of the duodenal bulb, (2) honeycomb, mushroom, or lobulated defect in the bulb, (3) variations in the appearance in the same and on repeated examination, (4) disappearance of deformity in the bulb when the prolapse is reduced, (5) absence of irritability of the bulb when there is no associated ulcer, (6) acceleration of gastric peristalsis, (7) increase in caliber of gastric mucosal folds, (8) multiple linear negative defects in the pylorus, (9) changes in the pyloric canal, which may be normal, narrowed, or widened, or show an annular cuff of varying extent.

Eight roentgenograms. I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Prolapse of the Gastric Mucosa Through the Pylorus: Physiological or Abnormal? Erik D. Bartels and H. Eltorm. Gastroenterology **20:** 100–104, January 1952.

In considering factors related to prolapse of the gastric mucosa, the authors evaluate anatomic, etiologic, diagnostic, and clinical aspects of the condition.

Abnormalities of gastric motility and hypertrophy of the mucosa brought about by gastritis or venous congestion are considered to be the two chief causes of the condition. Diagnosis is made roentgenographically by demonstration of a small bud of gastric mucosa or prolapse of a mass of gastric mucosa through the pylorus into the duodenal bulb. Symptoms consist of epigastric fullness, vague hunger pains, vomiting, and occasionally gastric hemorrhage.

The authors base their study on 240 consecutive patients complaining of dyspepsia in some form. Among these, 44 (18.3 per cent) were found to have a prolapse. Six of this number had severe gastric hemorrhage. Six of 34 patients receiving a gastric test meal showed achlorhydria. One patient had a gastric and 1 a duodenal ulcer; 3 had cholelithiasis.

An additional study of 42 patients without gastrointestinal complaints was made and in this group 21 presented mucosal prolapse.

The authors conclude that gastric mucosal prolapse is a normal finding in more than 25 per cent of patients examined. They do not regard the condition as an indication for surgery. I. R. BERGER, M.D.
VA Hospital, Chamblee, Ga.

Entrance of Common Bile Duct into a Duodenal Diverticulum. Report of a Case Corrected by Surgery. H. M. Blegen, A. V. Swanberg, and W. B. Cox. J. A. M. A. **148:** 196–197, Jan. 19, 1952.

The second portion of the duodenum is the usual location of the ampulla of Vater and is also the site of 65 per cent of duodenal diverticula. It is therefore not surprising to find the ampulla in a diverticulum. It is more surprising that only 6 such cases have been previously reported. The authors' case was recognized surgically. The radiologist reported a deformity of the duodenal bulb from ulcer and a lesion in the second portion of the duodenum, believed to be either a diverticulum or a tumor. Operation revealed a duodenal diverticulum, 4 or 5 cm. in diameter, projecting to the right from under the lateral margin of the duodenal curvature. The diverticulum was dissected and freed from the surrounding retroperitoneal connective tissue. The neck of the sac was found to enter the duodenum on the posterior wall of the second portion in the usual location of the ampulla of Vater. The terminal portion of the common duct, however, entered the diverticulum about 1.5 cm. above this point. The patient made a good recovery.

One roentgenogram; 2 drawings.
DONALD DEF. BAUER, M.D.
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Cystic Pneumatosis. O. E. Hansen. South African M. J. 26: 31–34, Jan. 12, 1952.

A case of cystic pneumatosis in a 29-year-old Bantu woman is reported. The patient was first seen in March 1950, complaining of abdominal pain, aggravated by taking food and then relieved by vomiting. A gastro-intestinal x-ray series failed to show anything of significance. The patient then felt well for a few months, but a year later was seen again, complaining of abdominal pain. The abdomen was distended and contained free fluid. Fluid obtained by paracentesis was biologically and culturally negative for tubercle bacilli. Roentgenograms of the chest showed thinning and elevation of the right diaphragm, suggesting interposition of the bowel. On barium enema examination, the position of the colon was normal, but gas was present under both sides of the diaphragm. Other odd collections of gas of uncertain nature were observed. A diagnosis of tuberculous peritonitis with coexisting cystic pneumatosis was made.

On laparotomy it was found that almost the entire small bowel was studded with glistening cysts, ranging in size from less than 0.5 to 5.0 cm. in diameter. Mesenteric and antimesenteric sides of the bowel wall seemed to be equally affected. Cysts were also seen on the small bowel mesentery, but the terminal ileum and large bowel were normal. A loop of small bowel was firmly adherent to the ventral surface of the liver, tethered by a bunch of grape-like cysts. Since this segment was edematous and turgid, approximately 12 inches of bowel were resected.

Vomiting began soon after the patient returned home. X-ray examination revealed almost complete pyloric obstruction. The abdominal cavity was reopened. The cystic pneumatosis was not as striking as at operation, and there was no free fluid. A hard mass, approximately 2 cm. in diameter, was palpable in the pyloric canal. Enlarged, firm subpyloric nodes, associated with the prepyloric tumor, suggested cancer. Accordingly, a high subtotal gastrectomy, with a retrocolic Hofmeister valve anastomosis, was performed. The histologic diagnosis was simple diffuse neurofibroma. The patient gained weight and two months postoperatively was able to resume her domestic duties.

This case supports the view that pyloric obstruction is the most common predisposing factor of intestinal gas cysts.

Two roentgenograms; 1 photograph; 2 photomicrographs.

Indications for Barium Enema in the Diagnosis of Carcinoma of the Colon. Michael Haggie. Lancet 1: 21–23, Jan. 5, 1952.

The case records of all patients with carcinoma of the colon admitted to the London Hospital in 1946, 1947, and 1948, were reviewed to determine how the condition was diagnosed. In all but 6 of the 110 cases in this group the diagnosis was confirmed at operation or at necropsy; 4 cases were considered inoperable, and 2 patients refused operation. In over half of the cases the tumor was located in the pelvic colon.

In 51 cases (46.4 per cent) an abdominal mass was palpable; in 29 of 31 cases, a barium enema study confirmed the site and colonic nature of the mass. Thirty-five patients (31.8 per cent) were admitted with acute or subacute intestinal obstruction and were operated upon as surgical emergencies. Likewise, 2 patients were seen with acute perforation. Sixteen cases (14.5 per cent) were diagnosed on digital or sigmoidoscopic examination; in only 3 of these was a barium-enema examination performed, and in only 2 was the site of the lesion confirmed. In 1 case the only physical sign was ascites, and a barium-enema study revealed the site of the growth. One patient was admitted with carcinomatosis with secondary deposits in the liver and superficial lymph nodes, and the diagnosis was confirmed at necropsy. In 4 cases (3.6 per cent) none of the above signs were present, and the diagnosis was made on the basis of a barium-enema examination.

Of 227 barium-enema studies during the year 1948, 163 showed no abnormality. Most of these examinations had been made to exclude carcinoma of the colon in patients with colonic symptoms without abnormal physical signs. With one possible exception, none of these patients had cancer of the colon two years later.

The author believes that the barium-enema examination is often made unnecessarily, because it is used to "exclude" rather than to confirm a diagnosis of cancer of the colon. A careful history and physical examination, followed by digital examination of the rectum and sigmoidoscopy, was sufficient to warrant a laparotomy or to make the diagnosis practically certain in 96 per cent of the cases in this series. The barium-enema study is of the greatest help in revealing the site and nature of an abdominal mass.

Four tables.

Perforation of Colon in the Newborn Infant. Recovery Following Operation. John E. Standard. Am. J. Surg. **83**: 107–111, January 1952.

A case of perforation of the colon in a newborn infant is reported. The baby appeared normal at birth and passed one meconium stool. On the second day the abdomen became distended and tympanitic, with mild erythema of the abdominal wall. Bowel sounds were absent on auscultation. A diagnosis was made of obstruction secondary to some congenital anomaly of the intestinal tract. Unfortunately, a barium enema was given, without first taking a scout film of the abdomen. A massive hydropneumoperitoneum was disclosed, but no evidence of intrinsic disease of the colon. On paracentesis, in the right subcostal region, a large amount of odorless gas gushed forth, followed by 20 c.c. of cloudy yellow fluid. The infant's condition improved immediately, and palpation revealed no masses or collections. A catheter was passed into the stomach, through which 5 c.c. of lipiodol was instilled. X-ray examination showed no evidence of perforation of the stomach or duodenum; however, extraluminal barium was obvious, indicating perforation of the colon. Laparotomy was performed immediately and some of the barium was aspirated. The site of the perforation could not be visualized with certainty, and a right transverse loop colostomy was carried out. Eight weeks postoperatively x-ray examination showed the colon to be normal in appearance, with no evidence of additional extravasation of barium. Intraperitoneal closure of the colostomy was done when the baby was about six months of age.

The diagnosis of perforation of the colon can usually be made by a scout film of the abdomen and in the presence of pneumoperitoneum barium should not be introduced either by mouth or by rectum; this is emphasized by the present case. If massive pneumoperitoneum is present, abdominal paracentesis should be performed prior to surgery to decrease respiratory

distress. In the author's case this procedure was thought to be life-saving.

Five roentgenograms; 1 photograph.

Obstruction of Colon by Gall-Stone. J. C. F. Lloyd Williamson. Brit. J. Surg. **39**: 339–341, January 1952.

The author reports the case of a patient with evidence of intestinal obstruction A barium-enema study showed a complete block in the sigmoid colon. Laparotomy disclosed a hard mass surrounded by inflammatory tissue. This was thought to represent an obstructing carcinoma and a portion of the colon was resected. On examination of the specimen it was found that the obstruction was due to a large impacted calculus. There was a perforation in the antimesenteric border half an inch proximal to the stone. The patient recovered after a stormy postoperative course.

Acute intestinal obstruction by gallstones is rare, and in the great majority of the cases the obstruction is in the small bowel. Stones that pass by natural routes do not seem to cause a block in the bowel. Obstructing stones pass by fistula. In one series of cases mentioned, the fistulous tract extended from the gallbladder into the duodenum in 101 instances, into the colon in 33, and into the stomach in 7.

In the cases reported in the literature a preoperative diagnosis was made only 7 times. Frequently, as in this instance, the nature of the obstructing lesion may be overlooked at the operating table. Some of the positive radiographic findings which have been mentioned are demonstration of concrement in the lowest dilated loop of small intestine, a filling defect produced by the stone following administration of barium, and gas or barium in bile passages showing a fistula.

One roentgenogram; 2 photographs in color.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Calcium Carbonate in the Gall-Bladder. L. Wynn Houghton. Brit. J. Surg. **39**: 336–338, January 1952.

The case history of a patient whose gallbladder contained pure calcium carbonate is presented. The diagnosis was suspected preoperatively because the density of the gallbladder did not decrease during a six-day period following administration of gallbladder dye. The findings closely resembled those on a cholecystogram obtained two years earlier, but the diagnosis was not made at that time because a preliminary film was not taken. At that examination the gallbladder did not change in configuration following a fatty meal.

The author reviews previously reported cases as well as the experimental work that has appeared in the literature. Apparently infection and obstruction of the cystic duct are the important factors in producing calcium carbonate in the gallbladder. The pH of the bile may also play a part.

The diagnosis rests solely on the radiological findings. It should be considered when: (1) the gallbladder outline is visible without cholecystography; (2) when there is no change in configuration of the gallbladder following a fatty meal; (3) when the gallbladder shadow persists after cholecystography; (4) when a stone is present in the area of the cystic duct with a visualized gallbladder; (5) when shadows unlike gallstones are found with a non-visualized gallbladder during cholecystography.

Two roentgenograms; 1 photograph.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Acute Gaseous Cholecystitis. B. R. Mooney and K. E. Matzinger. Canad. M. A. J. **66**: 66–67, January 1952.

The authors review 23 cases of acute gaseous cholecystitis which have been reported in the medical literature and add 1 of their own. Of the 24 patients, 20 were males and 4 females; 8 were diabetics. The causative organisms have been found to be *C. welchii*, *E. coli*, and anaerobic streptococci and staphylococci. Since none of these bacteria is uncommon in gallbladders routinely submitted for pathologic examination, it seems that there must be some lowering of the normal resistance of the gallbladder in cases where a gas infection develops.

The clinical course of the disease does not differ from that of any acute cholecystitis. Preoperative differentiation is therefore primarily a radiologic problem. The radiological signs are pathognomonic. In the early stage gas can be seen within the lumen of the gallbladder, and an air-fluid level is apparent on the erect film. Later, gas outlines practically the entire gallbladder wall, forming an almost continuous layer in the submucosa. Gas outside the lumen in the region of the gallbladder indicates perforation and a pericholecystic abscess. If the patient is successfully treated conservatively, the gas disappears from the lumen and the wall of the organ within a period of several weeks.

Of the 23 cases previously recorded, 15 were treated surgically, with 4 operative deaths. The types of operation attempted on these cases are not listed. The remaining 8 cases received medical treatment and all recovered. Operation after the acute symptoms have subsided (as in the authors' case) is less dangerous, but it is usually difficult because of numerous adhesions.

Three roentgenograms.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Henoch's Purpura: Its Radiological Diagnosis. W. A. Jones and W. Ford Connell. J. Canad. A. Radiologists **2**: 56–59, December 1951.

In Henoch's purpura the striking intestinal symptoms, originally described as characteristic of the disease, may antedate the purpura by days or weeks and thus produce considerable diagnostic confusion. A case is presented in a boy of sixteen, who for nine days prior to admission experienced severe colicky pain, periodic vomiting, constipation, and hematemesis. A radiological study of the gastro-intestinal tract four days after admission showed the pyloric portion of the stomach and duodenum to be rather rigid and narrowed, with an irregular notched and scalloped silhouette. The mucous membrane pattern was abnormal or lost. There was stasis in the greater portion of the duodenum with similar changes in the jejunum. A sigmoidoscopic examination six days after admission revealed a congested rectal mucosa with numerous small hemorrhagic areas, several of which had apparently ulcerated. The patient's condition became progressively more critical with increasingly severe abdominal pain and rebound tenderness suggestive of peritonitis. Exploratory laparotomy showed the small bowel to be patchily thickened and edematous from the pylorus to the terminal ileum, but no peritonitis.

Purpuric spots first appeared twenty-nine days after admission and thirty-eight days after the first symptoms of illness. The purpura was most obvious on the thighs, but appeared in successive crops over the entire

lower extremities. Approximately one week later the condition changed for the better, and one month after this rapid change the boy was sent home. A few weeks later, fourteen weeks after the onset of the illness, there was a recurrence of the purpura and the ankles became sore and swollen for a few days, but the patient's general health was unaffected. He was followed thereafter for a period of four years. For two years the gastro-intestinal pattern remained abnormal, but at the time of the report (four years after the original illness) the findings had returned to normal.

The authors review briefly similar cases which have been reported. It is their opinion that the appearances of the gastro-intestinal tract presented originally were those of ulceration and inflammation in the stomach and small bowel. It is possible that disordered motor fuction of the bowel may also have played a role.

Five roentgenograms. I. MESCHAN, M.D.
University of Arkansas

Kaposi's Sarcoma. Case Report with Unique Visceral Manifestations. Benjamin Sherwin and Harry Gordimer. Ann. Surg. **135**: 118–123, January 1952.

Although Kaposi's sarcoma may arise as a primary lesion in any part of the body, most frequently it appears first on the skin. In the case reported, a man of sixty-one had suffered from cutaneous manifestations for eight years, after which visceral disease developed. The latter was unique in that it consisted of numerous intra-abdominal mesenteric cysts. One of these attained "the size of an infant's head" and ruptured into the lumen of small intestine. It therefore appeared roentgenographically as a large air cyst.

The skin lesions had been controlled for eight years by radiation therapy but the patient finally succumbed approximately five months after visceral disease became evident.

One roentgenogram; 3 photomicrographs; 2 photographs. D. D. ROSENFELD, M.D.
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THE DIAPHRAGM—HERNIA

Unilateral Paralysis of the Diaphragm in the Newborn Infant Due to Phrenic Nerve Injury, With and Without Associated Brachial Palsy. Nathan Schifrin. Pediatrics **9**: 69–76, January 1952.

Unilateral paralysis of the diaphragm due to injury of the phrenic nerve with or without brachial palsy of the homolateral side is a relatively uncommon condition in the newborn infant. It has usually followed delivery from the breech position and has occurred on the right side. The author presents 2 cases of isolated phrenic nerve injury in newborn infants, which he believes to be the tenth and eleventh to be recorded, and 2 cases of phrenic nerve injury associated with brachial paralysis.

The presenting symptom at birth is respiratory difficulty. If the infant survives the neonatal period, there generally follows a latent period of variable duration during which rapid, shallow respiration is the only symptom. Some time later respiratory difficulty becomes more acute and attacks of cyanosis supervene. This is probably due to the fact that growth has required further expansion of pulmonary volume which is not possible because of the elevation of the involved diaphragm or because there has been some compromise of existing adequate pulmonary capacity by respiratory infection.

Examination of the patient with unilateral diaphragmatic paralysis reveals dullness at the pulmonary base on the involved side because of the elevated diaphragm. There may be flattening instead of the normal protuberance in the epigastric region on the side of the paralysis. Flaring of the chest on the involved side during inspiration may be noticed. This is caused by the disproportion between the contraction of the intercostal muscles and the diaphragmatic pull on the thoracic cage on the paralyzed side. Fluoroscopic examination of the chest furnishes the pathognomonic sign (Kienböck's sign): the diaphragm on the involved side is elevated and paradoxic movement with mediastinal flutter is noted. The affected diaphragm moves upward on inspiration pushing the mediastinum toward the normal side. The uninvolved diaphragm moves normally during respiration. The diagnosis may be missed if only roentgenograms are taken, and the author urges fluoroscopic as well as roentgenographic examination of the chest in any newborn infant with respiratory difficulty.

The treatment of diaphragmatic paralysis secondary to phrenic nerve injury in the newborn is symptomatic. Good nursing care is essential because of the danger of vomiting and aspiration. Prophylactic chemotherapy against the development of pulmonary parenchymal infection is thought advisable. Recovery is usually complete.

Three roentgenograms; 1 photograph; 1 table.

Subcostosternal (Morgagni) Diaphragmatic Hernia. Report of a Case of Hernia Containing Stomach, Transverse Colon, and Omentum, with Review of the Literature. Harry C. Saltzstein, Laurence M. Linkner, and Schayel R. Scheinberg. Arch. Surg. **63**: 750–765, December 1951.

The authors present a detailed review of the 44 cases of subcostosternal diaphragmatic hernia that have been reported in the literature and add a case of their own.

The classification of diaphragmatic hernias according to Harrington is given. There are two major divisions: (1) traumatic (including inflammatory necrosis) and (2) non-traumatic. The non-traumatic varieties are congenital or acquired structural deficiencies. These include (1) esophageal hiatus hernia, (2) hernia through the pleuroperitoneal hiatus, (3) congenital absence of the diaphragm, and (4) herniation anteriorly through the foramen of Morgagni. The term subcostosternal diaphragmatic hernia is given to this last type. It is located anteriorly on either side of the sternum and immediately behind the anterior costal attachment of the diaphragm. A hernial sac is always present.

The incidence of this type of hernia was found to be 2.6 per cent in a total of 680 diaphragmatic hernias of all types as reported in six different series. Eight of the total of 45 cases now recorded occurred in children twelve years of age or younger. In infancy and childhood the liver has been found in the sac, whereas only one of the adult hernias contained liver. No hernias in infants or children contained omentum. The colon was found in the sac in all age groups and in 73 per cent of the 45 cases. The presence of the colon causes only mild abdominal symptoms, if any.

The stomach enters the sac only after the colon has been in it for a matter of years. Cases in which this occurs are the only ones in which sharp and sudden obstruction is encountered.

One case is reported in detail. In this case the colon had evidently been present in the sac for some years

(certainly as long as eight years), for a re-evaluation of an earlier chest roentgenogram showed gas-containing right lower chest shadows. There were few symptoms, mild cough and no gastro-intestinal disturbances. After sudden exertion four days before admission to the hospital, which involved bending forward, pyloric obstruction developed, with severe alkalosis and hypochloremia, progressing to the point of peripheral circulatory collapse, with cyanosis and a blood pressure drop to 70/40. Potassium chloride given intravenously immediately reversed this state of shock and transformed a critical and almost terminally ill patient to one who was able to withstand surgery. At operation a large right subcostosternal diaphragmatic hernia was found, containing 7 in. (18 cm.) of transverse colon, the entire omentum, and the distal two-thirds of the stomach. The contents were easily replaced into the abdomen, the hernia sac was repaired, and the abdomen closed.

Four roentgenograms; 1 chart; 5 tables.

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Diaphragmatic Hernia. Henri LaPointe. J. Canad. A. Radiologists **2**: 65–69, December 1951.

The clinical recognition of diaphragmatic hernia from the subjective symptoms alone is very difficult. Only the roentgen ray examination can be depended upon for a diagnosis. Six cases are presented in moderate detail, of which only one displayed any clinical evidence of the existence of a hernia. Physical findings may likewise be deceptive.

A presumptive diagnosis may be made from the routine postero-anterior and lateral chest films. Translucent areas—with or without fluid levels—are sometimes seen. At times there may be an area of irregular opacity at the base of one lung or occupying an entire hemithorax. Retrosternal gas pockets are a striking feature. The contour of the diaphragmatic dome may be obscured on one side. A dense circular shadow may be superimposed upon the heart shadow, due to the wall of the herniated upper portion of the stomach. Occasionally the heart appears to be displaced to the side opposite the hernia. For corroboration of the findings and demonstration beyond doubt of the existence of hiatal hernia, barium meal and/or enema study must be employed.

In the 6 cases reported, accurate preoperative diagnosis made it possible to effect a cure. These cases are representative of various types of hernia through recognized points of weakness in the diaphragm.

Six roentgenograms.

I. MESCHAN, M.D.
University of Arkansas

Herniation of the Stomach, Transverse Colon, and a Portion of the Jejunum into the Pericardium. G. R. Crawshaw. Brit. J. Surg. **39**: 364–366, January 1952.

A case of peritoneo-pericardial diaphragmatic hernia is presented. The patient was seen by the author with a history of vomiting all solid foods for one week and liquids, as well, for one day. He gave a history of trauma to the chest followed by episodes in which food seemed to "stand" in the epigastrium. He had recently experienced breathlessness and palpitation. Roentgenograms showed gas bubbles superimposed on the cardiac shadow, and following a barium swallow it became evident that the stomach was twisted upon its axis and herniated into the thorax. Unfortunately, no lateral films were taken of the chest. At surgery peristalsis was observed under the pericardium and the diagnosis was made. The abnormalities were corrected surgically and the patient made an uneventful recovery.

Only 9 cases of this condition could be found in the literature. The author's patient apparently was the second to survive the surgical procedure for correction. Four of the 9 earlier cases were in newborn infants and apparently congenital. Most of the cases in adults were also considered as congenital by those reporting them, but the author feels that his case was definitely on a traumatic basis.

Three roentgenograms.

DEAN W. GEHEBER, M.D.
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THE MUSCULOSKELETAL SYSTEM

Arthrography. K. Lindblom. J. Fac. Radiologists **3**: 151–163, January 1952.

The main object of arthrography is the demonstration of fracture or destruction of cartilages; rupture and atrophy of menisci, ligaments, or tendons; capsular rupture; loose bodies; hypertrophy and tumors of the capsule. For this purpose it was found necessary, when a water-soluble dye was used, as Uroselectan or Perabrodil, that it be miscible with the synovial fluid. The author found Diodrast alone preferable to a mixture of Diodrast and oxygen or oxygen alone. The amounts of the contrast medium used were: 10 c.c. in the knee joint, 6 to 7 c.c. in the shoulder and hip, 3 to 4 c.c. in the elbow and ankle. In small joints, such as the mandibular joint, 0.5 to 1.0 c.c. was sufficient. The dye was spread by movements at the joint.

Arthrography is considered of most value in the knee joint. Negative findings at operation without previous arthrography numbered 15 per cent but with arthrography the number of errors was reduced to less than 5 per cent. An additional advantage is the demonstration of combined lesions. The technic for the instillation of the contrast medium into the joint and the various positions for obtaining arthrograms of the knee are given.

In shoulder arthrography, the main purpose is the study of ruptures of the supraspinatus tendon and lesions of the long biceps tendon. In the ankle, ligamentous injuries are studied. In the hip, fracture, dislocation, capsular tumor, arthritis, loose bodies, and studies of the ligamentum teres are of the greatest interest. Ligamentous tears and loose bodies are studied in elbow arthrography. For the wrist and mandibular joint arthrography is rarely used.

Fifty-eight roentgenograms; 8 photographs.

LAWRENCE A. PILLA, M.D.
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Ewing's Sarcoma. Lawrence J. McCormack, Malcolm B. Dockerty, and Ralph K. Ghormley. Cancer **5**: 85–99, January 1952.

Although the tumor now known as Ewing's sarcoma or Ewing's tumor of bone was described three decades ago, only four series of more than 50 cases have been recorded. A number of small series have been reported but in these, as in the larger series, criteria for diagnosis have varied widely. Accurate histologic evalua-

tion of Ewing's tumor has been complicated by the rarity of the neoplasm and the employment of irradiation as a basic factor of diagnosis in lieu of surgical biopsy. The authors felt that a careful and critical restudy of a large group of cases might add something to present knowledge of this controversial tumor.

The records of all cases in which a diagnosis of Ewing's tumor, or any of its synonyms, was made at the Mayo Clinic from 1907 through 1949 were considered. To these cases were added 50 of unclassified malignant bone lesions and more than 350 cases of osteogenic sarcoma. In every case specimens of tissue were examined. From this large group, 80 cases were selected in which the correct diagnosis seemed to be Ewing's sarcoma. Clinical records and available roentgenograms were then finally reviewed to complete a predominantly pathological study. Four phases were considered in the study of each case: (1) clinical aspects, including such factors as family history of malignant tumor, age, sex, symptoms, and physical and laboratory findings; (2) roentgen aspects; (3) pathological findings; (4) treatment and its results.

The patients were young, 85 per cent being less than thirty years of age. Sixty-one per cent of the patients were men. Pain and swelling were by far the commonest symptoms. In 46 cases pain was the initiating symptom and in 15 cases it was the only symptom. Swelling was noticed by 58 patients; it was the first symptom observed by 12 and the only symptom of 9. In 75 per cent of the cases, bones of the extremities including the shoulder girdle were involved. A predilection for the metaphyses in long bones was noted.

Unfortunately, the original roentgenograms were available in only 22 recent cases. In 16 additional cases, however, photographs of the original films were found that were suitable for study. Four basic changes in the bony pattern could be identified: (1) mottled lysis, (2) sclerosis, (3) cystic loculation, and (4) periosteal reaction. In 26 cases the chief lesion was mottled lysis of the bone. The reverse of this, namely, increased density or sclerosis, was present in 6 cases. A cystic-appearing lesion was present in 3 cases, and a periosteal reaction was noted in 16. This periosteal reaction was extremely variable. In 8 cases it was represented by a single small lamination close to and paralleling the bone. In 4 cases typical "onion peeling" (multiple laminations) was present. Striations perpendicular to the bone were noted in only 4 cases, but in 1 were so striking as to simulate the "sunburst" of an osteogenic sarcoma. A diagnosis of Ewing's sarcoma was suggested in only 12 cases, although in 41 some type of malignant tumor of bone was mentioned.

The histopathology of Ewing's tumor is at best difficult to interpret. Basically this tumor forms nothing but cells arranged in sheets and nests separated by a finely vascularized stroma, which negates any attempts to derive histogenesis. Microscopically the cells themselves are essentially naked nuclei, cytoplasm being rarely recognized as such. These nuclei are round to oval, fairly regular as to size and shape, and possessed of a finely divided chromatin pattern with rare nucleoli. The regularity in size and the homogeneous ground-glass appearance are of great importance. Equally so is the absence of spindle cells, multinucleated cells, and tumor giant cells.

In general, three types of treatment were employed in these cases, namely, operation, irradiation, and the administration of Coley's toxins. Each of these methods has been used singly or in some form of combination with the others. In 29 cases the principal method of attack was surgical and in 42 cases irradiation of the primary tumor was the chief treatment. The results of treatment by any method were disappointing. More than half of the patients died within the first year, but a few have lived for many years. The five-year survival rate for the patients treated surgically was slightly higher than for those treated by other methods (15.4 per cent versus 10.8 per cent), but this slight variation is not statistically significant. The critical feature in control seems to be a combination of early diagnosis and adequate therapy. The authors conclude that Ewing's sarcoma is a neoplastic entity, whatever its histogenesis may finally prove to be.

Three roentgenograms; 11 photomicrographs; 1 photograph; 6 tables.

Myeloma of Bone. John Kesterson and Barton McSwain. J. Bone & Joint Surg. **34-A:** 224–228, January 1952.

An analysis of 14 cases of microscopically proved myeloma of bone is presented here. These represent 6 per cent of all bone tumors and 20 per cent of malignant bone tumors seen in the Surgical Pathology Laboratory of Vanderbilt University Hospital from 1925 through 1939. The ages of the patients ranged from twenty-nine to eighty-eight years. Eleven patients were males. The sites of bone involvement were widely distributed. Microscopic examination showed the predominating cell in 11 patients to be the plasma cell. In the other 3 patients there were approximately equal numbers of reticulum cells and plasma cells. Survival after admission varied from six months to more than nine years. The history of the patient who lived nine years and five months after diagnosis of the disease is presented. He was a man of twenty-nine when first seen, with roentgen evidence of a rarefying lesion involving the major portion of the sacrum and part of the fifth lumbar vertebra. A portion of the thinned outer sacral plate was removed together with friable, vascular tumor, which proved to be plasma-cell myeloma. The patient was given twelve roentgen treatments, consisting of 800 r to the midline and 2,800 r to each of two portals over the sacral area, and was able to return to work. In the ensuing years evidence of disease developed in the ribs, skull, vertebrae, shoulder girdle, pelvis, humerus, and other bones. Repeated roentgen therapy was given to the involved areas and the patient continued to work up to ten months before his death.

Six roentgenograms; 1 photomicrograph; 1 drawing.

RICHARD P. STORRS, M.D.
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Ollier's Disease. James A. Heckman. Arch. Surg. **63:** 861–865, December 1951.

In 1900 Ollier first described a condition characterized by multiple areas of unossified cartilage in the metaphyses of long bones. It is now most usually called multiple enchondromatosis as it is due to a developmental error in endochondral ossification. There is a tendency for unilateral distribution with involvement of one bone or several bones of one extremity. Enchondromas of the bones of the hands are rather

common. The skull, sternum, ribs, and vertebral column are only rarely involved. Shortening of the involved limb is characteristic. Deformities are common; fractures are relatively unusual. The roentgen appearance is characteristic: large areas of cartilage arranged in columns in the metaphyseal regions. Blood calcium, phosphorus, and phosphatase studies are normal.

To be considered in the differential diagnosis are Albright's syndrome, dyschondroplasia associated with hemangiomas and osteogenesis imperfecta.

One case is presented in which a ten-year-old girl showed multiple enchondromas in the metaphyseal regions of the right femur, tibia, and fibula. She had a marked deformity and shortening of the right leg and was treated by amputation. She made an excellent physical and psychological adjustment.

Three roentgenograms; 2 photographs.

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Infantile Cortical Hyperostosis (Caffey-Smyth Syndrome). Jacob Rosenblum and Bernard Greenberg. Am. J. Dis. Child. **82:** 710–716, December 1951.

In 1945, Caffey and Silverman first described a new syndrome which they called "infantile cortical hyperostosis" (Am. J. Roentgenol. **54:** 1, 1945. Abst. in Radiology **46:** 538, 1946). Shortly thereafter, Smyth, Potter, and Silverman reported a group of cases with similar changes under the title "Periosteal Reaction, Fever and Irritability in Young Infants: A New Syndrome?" (Am. J. Dis. Child. **71:** 333, 1946. Abst. in Radiology **48:** 550, 1947). The name Caffey-Smyth has been suggested for this syndrome, which has now become well known to pediatricians and radiologists.

The authors report 2 additional cases of infantile cortical hyperostosis. In both patients symptoms began before the age of three months. Both showed the bony involvement and facial appearance characteristic of the syndrome. Pseudoparalysis of the right upper extremity was present in the first case. This finding has been observed in other cases and it is thought that it is most likely due to infiltration of the scapulae. Scapular involvement is usually unilateral, but in the authors' second case both scapulae showed hyperostosis.

Four roentgenograms; 1 photograph.

Brucella Infection of Bones and Joints. Charles N. Ploussard. Am. J. Roentgenol. **66:** 910–914, December 1951.

Brucellosis attacks the vertebrae more often than any other part of skeletal system, the most common site being in the lumbar spine. It is most often dry, though abscess formation has occurred.

Joint manifestations are not uncommon, having been reported in 32 per cent of two series of cases. Steindler (J. Iowa State M. Soc. **30:** 256, 1940) states that evidence of joint involvement occurs eight to twelve weeks after the onset of the disease, which helps to differentiate it from pyogenic arthritis or osteomyelitis. Many cases of myotendinitis will be found to be due to *Brucella*.

A case is reported of brucellosis of the hip joint and proximal femoral shaft.

Ten roentgenograms.

I. EARL HOLMES, M.D.
University of Louisville

Brucella in Tissues Removed at Surgery. Lyle A. Weed, David C. Dahlin, David G. Pugh, and John C. Ivins. Am. J. Clin. Path. **22:** 10–21, January 1952.

Thirteen cases are reported in which organisms of the genus *Brucella* (*Br. suis, abortus* or *melitensis*) were present in tissues removed at operation for chronic lung infection and were probably causally related to the condition. While the presence of chronic brucellosis is frequently difficult to prove, it is emphasized that in these cases the diagnosis was made by isolating and identifying the organisms. After isolation of the organism, discussion with the patient usually revealed either a history of probable exposure to *Brucella* or previous symptoms of the disease. The cases are reported in detail in order that the material may be of interest to clinicians, radiologists, surgeons, and pathologists alike. The close co-operation of these four groups is essential for the understanding of such chronic infections and for the greatest benefit to the patient. Only the roentgen aspects of the paper will be abstracted here.

Brucellosis may affect many tissues of the body, and in most cases, especially when soft tissues alone are affected, roentgen diagnosis of the condition will be impossible. This applies to those patients in whom the lymph nodes, kidney, and spleen are affected. In other instances, the roentgenologic aspects may be quite deceiving. One of the authors' patients had a large granuloma of the lung resulting from brucellosis. The most logical diagnosis was tumor of the lung and, because of the enlargement of the hilar nodes, bronchogenic carcinoma was suspected. In this case diagnosis could be made by operation only, and although the outlook appeared to be unfavorable preoperatively, it was most important that thoracotomy be performed.

In the cases in which the prepatellar bursa was affected it was not particularly reasonable to suspect brucellosis; however, the degree of swelling of the bursa was greater than is usually encountered secondary to trauma, and this in itself should suggest the possibility that the bursitis is due to an infectious process of relatively long duration. The cases with involvement of the humerus and the femur were most interesting, since there was definite evidence to suggest that the lesions were the result of chronic infection. They were sharply outlined, indicating that the process had been present for a considerable time, and in each instance there was a break in the cortex of the bone, which would indicate that the lesions were not cysts or tumors but rather unusual forms of osteomyelitis. The periosteal proliferations were also indicative of an infectious process. When such infections are encountered, brucellosis must be considered, especially since tuberculosis of the bone is being met with less frequently, and since tuberculosis of the long bones in adults is particularly uncommon.

Certainly it is impossible for the roentgenologist to make a bacteriologic diagnosis in any case, but on the other hand he can suggest that certain organisms may be the offending ones. When evidence shows that an infection of long duration is affecting the bone and causing relatively little reactive proliferation, organisms such as *Brucella* should be considered. It is doubtful whether it is possible to distinguish roentgenologically between lesions caused by *Brucella* and those resulting from tuberculosis or some of the fungi. In some instances, however, roentgen examination may lead to

the proper bacteriologic investigation if the possibility of brucellosis is suggested by the roentgenologist.

Four roentgenograms; 4 photomicrographs.

Milkman's Pseudofracture. A Form of Osteomalacia. Donald J. Magilligan and Peter J. Dulligan, Jr. J. Bone & Joint Surg. **34-A**: 170–174, January 1952.

Milkman in 1930 reported a case of multiple, symmetrical, incomplete fractures as "pseudofractures." He originally classed his case with those of Looser, in which similar changes occurred with hunger osteopathy, late rickets, and osteomalacia. Later, in a follow-up report, he stated that his case represented a distinct new clinical entity and not osteomalacia. Albright and Reifenstein (The Parathyroid Glands and Metabolic Bone Disease, Baltimore, Williams & Wilkins, 1948) have more recently classified Milkman's syndrome as a form of osteomalacia.

The authors present a case of bilateral pseudofractures of the femoral necks occurring in a 45-year-old female with elevated fat content in the stool, high alkaline phosphatase in the blood, and x-ray evidence of multiple pancreatic calculi. The mechanism of the disturbance in this patient was considered to be steatorrhea, due to pancreatitis resulting in excessive loss of fat and of fat-soluble vitamins A, D, K, and E in the stools. As a result, the absorption of vitamin D, which in turn regulates calcium absorption, was reduced below normal. The formation of insoluble calcium soaps of fatty acids in the bowel resulted in further calcium loss. The symptoms cleared and the pseudofractures disappeared under treatment with an emulsifying agent by mouth, to increase fat absorption, and multivitamin preparations including 15,000 units of vitamin D daily.

Three roentgenograms. RICHARD P. STORRS, M.D.
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Primary Hyperparathyroidism (Adenoma) Simulating Sarcoidosis. Report of a Case. H. W. Salmon and G. G. Meynell. Brit. M. J. **2**: 1440–1442, Dec. 15, 1951.

A single case is reported in which sarcoidosis was suspected before the correct diagnosis of hyperparathyroidism was made. At first glance one might think this improbable, but analysis of the findings reveals a number of similarities. Cystic bone changes, elevated calcium levels in the blood and urine, elevated serum phosphatase, and a reticulated appearance of the lung fields may occur in either disease. The electrocardiographic changes are similar.

Generalized osteoporosis should be found in hyperparathyroidism and normal values for serum protein and A/G ratio, while in sarcoidosis the serum proteins are raised and the A/G ratio is reversed.

Several authors are cited who also noted a similarity between the two conditions.

Four roentgenograms; 1 photograph; 2 tables.
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Anatomical Variations in the Articulation Between the Second and Third Cervical Vertebrae. Lewis M. Overton and J. W. Grossman. J. Bone & Joint Surg. **34-A**: 155–161, January 1952.

The anatomy of the cervical vertebrae is such as to allow rotation at the first two cervical joints. Below this level there are normally free flexion, extension, and lateral motion, but only slight rotation. Anatomical variation in the planes and angles of inclination of the apophyseal joints of any of the cervical vertebrae will allow irregular motion and may result in instability.

A study of 36 cadaver specimens indicated that such variations are not infrequent. In all these specimens the variations involved the articulations between the second and third cervical vertebrae. In 18 of the specimens the changes were insignificant. In the remainder they were sufficient to allow marked instability. In all of this group there was asymmetry in either the plane, the angle of inclination, or the size of the joint.

The authors cite a previous study of 21 cases of cervical radicular pain localized to the third cervical nerve segment, all of which showed variations in the apophyseal articular processes of the second and third cervical vertebrae (Overton: Am. Surgeon **17**:343, 1951). This correlation suggests that the changes described may cause irritation of the third cervical nerve, and may result in pain in the distribution of this nerve.

Two roentgenograms; 4 groups of drawings; 1 table.
RICHARD P. STORRS, M.D.
Syracuse, N.Y.

Pyogenic Osteomyelitis of the Spine. John E. Wear, George J. Baylin, and Thomas L. Martin. Am. J. Roentgenol. **67**: 90–94, January 1952.

This presentation is based on a study of 33 cases of pyogenic osteomyelitis of the spine. Symptomatically, the patients fell into five categories. Twenty patients complained of back pain, 3 had pain in the chest, 5 had the so-called "hip-leg" syndrome, 4 had abdominal pain, and 1 developed meningeal signs. Ten of the cases were classed as acute, 4 as subacute, and 19 as chronic.

Anatomically, the vertebral body contains a large sinusoidal venous plexus that lends itself well to stasis and therefore to infection. The disk is believed to be involved by direct extension of the infectious process from the vertebral body.

The earliest roentgenographic change is localized rarefaction of the vertebral body and/or narrowing of the adjacent disk space. Such changes may also be seen in early tuberculosis of the spine. However, certain other features of the pyogenic form help in distinguishing the two. In pyogenic osteomyelitis the degree of rarefaction is more marked, the progress of bone destruction more rapid, and there is early evidence of bone reaction and proliferation. Osteophytic bridging between adjacent vertebrae is another distinguishing feature often occurring within a few months, whereas such formations are quite rare in tuberculosis. Primary involvement in some portion of the vertebra other than the body favors a pyogenic origin. Paravertebral abscess formation, although it occurs in non-specific types of infection, is uncommon. Finally, the degree of deformity and disk collapse is generally less than is seen in tuberculosis of the spine.

A plea is made for careful history taking and scrutiny of spine films. Oblique views, spot films, and laminagraphy are recommended in the evaluation of early lesions where changes are minimal. Accurate, early diagnosis is of great aid in proper management and treatment of this condition.

Five roentgenograms. R. A. SILVER, M.D.
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Rheumatoid (Ankylosing) Spondylitis: Its Early Manifestations and Early Diagnosis. James H. Young. M. J. Australia **2**: 761–764, Dec. 8, 1951.

Rheumatoid spondylitis is commonly thought of as a disease characterized by pain and progressive stiffness in the lumbar region followed by involvement of the thoracic and then the cervical portions of the spine, perhaps also with involvement of the hip joints. Complete ankylosis of the spine and even ankylosis of every peripheral joint may ensue. In recent years, however, it has become apparent that in the early stages symptoms are often intermittent, and that in many cases spinal rigidity never develops. Since early rheumatoid spondylitis seems to be arrested by roentgen irradiation, it is important that it be recognized and treated promptly. Roentgen changes must be sought in the sacroiliac joints of patients who complain of pain in the back, buttocks, lower limbs, or chest, or of pain and swelling of a joint of the lower limb, especially in the second, third, and fourth decades. Fifty-three of the author's last 60 cases of spondylitis occurred between the ages of sixteen and forty.

In the adult the earliest roentgen sign appears to be the absence of the fine white lines of subchondral bone along the edges of the sacroiliac joints. The joint margins are less distinct than normally, and the joints resemble those of the adolescent. The earliest roentgen sign in the sacroiliac joints of the adolescent, and the second sign to appear in the adult, is sclerosis of the lower part of the articular portion of the ilium. The next sign to appear in both adolescents and adults is erosion of the margins of the sacroiliac joints. The normal irregularity of the joint margins in the adolescent should not be mistaken for erosion.

Early writers thought that rheumatoid spondylitis was often caused by gonorrhea. In one recent series, however, gonorrhea was found no more frequently than in the general population. The author thinks it is probable that gonorrhea initiates rheumatoid spondylitis in the same way it initiates rheumatoid arthritis.

Radiological changes have been found in the sacroiliac joints of young patients suffering only from pain and swelling of one or more joints in the lower limb. It is submitted that these patients are suffering from rheumatoid spondylitis in which the manifestations are confined to a peripheral joint.

Twelve roentgenograms.

A Study of Late Results From Disk Operations. Present Employment and Residual Complaints. A. L. Eyre-Brook. Brit. J. Surg. **39**: 289–296, January 1952.

The author discusses the results of 117 operations performed upon patients with a preoperative diagnosis of prolapsed intervertebral disk and a postoperative follow-up for a minimum period of one year. Herniation of a disk was confirmed at surgery in 99 of these cases. In 6 cases adhesions were the only abnormality found. One intradural tumor was discovered, and 11 patients showed no abnormalities.

The indications for surgery were severe symptoms resisting conservative treatment and chronic cases in which complete relief was not obtained by other means. Radiographic studies of the spine showed no evidence in support of the clinical diagnosis in 41 per cent of the cases; confirmatory signs of herniation of a disk were obtained in 47 per cent, and the radiographic evidence was "misleading" in 12 per cent. The author makes no mention of myelography.

In 47 (40 per cent) of the patients followed for a minimum of one year there were no complaints whatever referable to the back. In 24 cases persistent backache produced some disability. This latter group included the 11 patients who showed no abnormality of the disk at operation. Forty-five patients complained of only slight pain or transient disability. Some, for example, experienced loss of lifting power or a slight ache after heavy work. It is interesting to note that of 24 whose occupation could be classed as heavy work, 18 returned to their former activities with no pain. All of those returning to their former occupations had a disk prolapse proved at surgery. Three of the 6 who did not return to their previous occupations had been found to have no disk lesion.

Three roentgenograms; 2 charts; 5 graphs; 1 table.

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The Anatomy of the Pelvic Tear Figure. Victor B. Vare, Jr. J. Bone & Joint Surg. **34-A**: 167–169, January 1952.

The pelvic tear figure or "tear drop," a roentgenographic landmark seen in the anteroposterior view of the pelvis, is useful in that alteration of its relationship to adjacent structures is suggestive of some abnormality in the pelvic bones or structures making up the hip joint. By means of roentgenograms with lead foil in place on a specimen pelvis, this tear-drop-like figure was shown to be made up in its medial aspect by the cortical surface of the true pelvis and in its lateral aspect by the cortical surface of the middle third of the acetabular fossa.

One roentgenogram; 3 photographs.

RICHARD P. STORRS, M.D.
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Accessory Sacro-Iliac Articulations. Lee A. Hadley. J. Bone & Joint Surg. **34-A**: 149–155, January 1952.

The anterior-inferior portions of the adjacent surfaces of the sacrum and the innominate bone form the true sacroiliac joint. Only about one half of the adjacent surfaces are actually in contact. The remaining portions are separated by a deep cleft and normally are connected only by the posterior sacroiliac ligaments. Articular facets may bridge this space, however, and form accessory sacroiliac articulations. These are movable diarthrodial articulations with joint space, capsule, and articular surfaces. They are normally asymptomatic. When the planes of the normal and accessory articulations vary sufficiently to form a considerable angle, the sheering stress mechanically hinders the normal movements between the ilium and sacrum and may contribute to the formation of arthritic changes. Two types of accessory articulations are described, the superficial type and the deep type. Both types may occur in the same individual. Occasionally the two types become fused to form a large accessory sacroiliac joint.

Study of 185 anatomic specimens of half sacra revealed accessory sacroiliac joints in 18 per cent, while of 163 ilia 16 per cent showed accessory articular facets. Review of 200 consecutive roentgenographic examinations of patients with low back pain revealed accessory sacroiliac joints in 33.5 per cent. Of these, 36 per cent showed arthritic change consisting of thinning and irregularity of the joint space, bony exostosis of joint

margins, and eburnation of subjacent bone. The author concludes that these accessory sacroiliac articulations seem to be compatible with symptoms of low back pain and sciatica.

Six roentgenograms; 6 photographs.

RICHARD P. STORRS, M.D.
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Myelographic Diagnosis of Sacral Perineurial Cyst. Z. Edin Taheri, Paul Riemenschneider, and Arthur Ecker. J. Neurosurg. 9: 93–95, January 1952.

Sacral perineural cyst has come to attention in recent years as a possible cause of symptoms referable to the cauda equina. The symptoms include lumbosciatic pain and urinary retention. These cysts occur in the posterior spinal nerve roots within the perineural space. The cysts may arise from arachnoidal proliferation. A possible origin from a congenital diverticulum of the dura mater or a herniation of the arachnoid through a congenital defect of dura has been suggested. It may be that some of the cysts have a traumatic origin.

A case is presented of a 38-year-old woman who had suffered low back pain intermittently for fifteen years. The pain radiated down the posterior lateral aspect of the right lower limb and was increased by coughing or straining. Myelography was performed and a small amount of Pantopaque was observed to pass from the terminal portion of the dural sac to a small irregular diverticulum just caudal to the sac. The opaque medium did not return to the main portion of the sac after the patient was tilted back. On the basis of this finding, the diagnosis of sacral perineural cyst was made and the cyst was removed.

Two myelograms; 1 photograph.

HOWARD L. STEINBACH, M.D.
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Congenital Dislocation of the Hip. L. G. Pray. Pediatrics 9: 94–100, January 1952.

Since 1947, the author has had under his care 35 infants with hip dysplasia, subluxation, or dislocation. Only 2 of these patients were males. Three of the 35 cases were bilateral; 21 cases were left-sided. In 23 cases, the diagnosis was made before the infant was four months of age; in 5, between four and six months; in 2, between seven and twelve months, and in 5, between one and three years. There was only one instance of dislocation in an infant under six months of age, the rest having subluxation or dysplasia. In all 5 cases diagnosed after one year, dislocation of the hip was present.

Limited hip abduction has been found to be one of the most helpful signs in the early diagnosis of congenital hip dysplasia, but usually does not become manifest for several weeks after birth. Other signs, such as shortening of the affected extremity, changes in folds and creases, rotational attitude of the extremity, and tilting of the pelvis should be looked for.

Roentgenographic changes of hip dysplasia may be slight or lacking until the infant is three months of age. Between the sixth week and the third month the femoral head epiphyses begin to ossify and show on the film. There is delayed ossification in a dysplastic joint, as well as delayed ossification and development of the acetabular rim. There is usually a greater than normal angle of the acetabular roof with the horizontal, of over 30°. Slightly rotated projection may produce factitious flattening of one acetabular cavity and deepening of the other, resulting in a false positive diagnosis of hip dysplasia. There is displacement of the femoral head upward and outward in most instances, and in all in which dislocation is present. Shenton's line, the obturator-coxofemoral line, is elevated in its coxofemoral component. Push-pull roentgenographic studies show telescoping of the hip if dislocation is present, but not with dysplasia or subluxation. Telescoping can also be seen and felt clinically.

Twenty of the author's patients were treated with the Frejka pillow splint, and all but 1 made a quick, easy recovery. Seven infants were treated with casts alone, one with cast and bar, one with casts followed by open surgery. Two patients had primary open surgery. Four infants with clinical signs of hip dysplasia were not treated and within three months the signs subsided; the roentgen findings were equivocal in these cases.

Seven roentgenograms; 2 photographs; 3 tables.

Congenital Dysplasia of the Hip Joint in Early Infancy. Richard D. Hawkins. South M. J. 45: 18–24, January 1952.

Congenital dysplasia of the hip refers to a delayed and inhibited ossification of the cartilaginous structures entering into the formation of the innominate bone and femur, resulting in an inadequate and deformable joint socket. Primary dysplasia may be complicated by complete displacement of the femoral head from the acetabulum (luxation), or partial displacement (subluxation). Primary dysplasia with no displacement is called preluxation.

Prompt diagnosis of congenital dislocation of the hip is important since the best results are obtained if reduction is accomplished early. Frequently the condition is not detected until after weight-bearing has started and it is made evident by a limp.

The history is usually of little importance. There may be a delay in the infant's pulling himself up or in toddling with support, or there may be less movement of the affected lower extremity. Since association of congenital hip dysplasia and clubfoot is frequent, a roentgenogram of the hip should be obtained as a routine in all cases of this latter deformity.

Actual dislocation of the hip is rare under the age of six months. The physical signs seen are those due to an improperly formed joint socket. Relative immobilization of the hip may be the only early sign, with a range of movement of 45 degrees or less.

Asymmetrical skin creases in the thigh may be present, and elevation of gluteal and popliteal folds may be observed on the affected side. Shortening of the limb is not likely to be seen before weight-bearing, though the knee may be lower on the affected side when the child is placed supine with the hips and the knees flexed. The jerk or click sign of Ortolani may be valuable. To elicit this, the thighs are flexed 90 degrees and are gradually abducted. There is a palpable or audible jerk or click when the head meets the acetabular surface.

When congenital dislocation is suspected, x-ray examination should be done with the infant supine, the legs together, and the feet parallel and pointing upward. The most reliable early roentgenographic finding is deficiency of the upper margin of the acetabulum, as indicated by the acetabular index. A break in the obturator-coxofemoral curve is also of diagnostic

significance. The epiphyseal center of the head of the femur tends to be smaller than normal, less dense and irregular in outline. Bruce's measurements are helpful in evaluating dislocation of this center. A transverse line is drawn through the inferior tips of the ilia, and then lines are drawn perpendicular through the lateral tips of the acetabula. Normally the epiphyseal centers lie below the horizontal line and medial to the vertical. The center is in the normal position in preluxation; in subluxation it is below the horizontal, but lateral to the vertical line, and in luxation it is above the horizontal and lateral to the vertical line.

Six cases are reported.

Eight roentgenograms; 1 drawing.

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Degenerative Osteoarthritis of the Hip Joint. Pathogenesis of the Enlarged Femoral Head (Coxa Magna) and Defective Acetabulum. Thomas Horwitz. Am. J. Roentgenol. **67**: 95–102, January 1952.

The roentgenographic and pathologic backgrounds of degenerative osteoarthritis of the hip joint are analyzed, with particular reference to the form in which dominant changes occur in the proximal and superior portions of the joint. Special attention is focused on idiopathic cases, the so-called primary type. In advanced stages, the radiographic and pathologic changes in this primary type of the disease are indistinguishable from secondary osteoarthritis of the hip joint following Perthes' disease or displacement of the capital femoral epiphysis.

Roentgenographically, degenerative arthritis of the hip joint is generally interpreted on the basis of narrowing of the joint space, consequent upon thinning and loss of articular cartilage, and bony proliferation or exostosis formation. Anatomically, this bony proliferation may ring the articular surfaces peripherally to a variable degree or it may appear as elevations on the articular surface itself. In the more advanced stage of the "proximal" type, the hypertrophied femoral head may protrude laterally from the confines of the acetabulum, and this appearance will be exaggerated by actual lateral displacement of the head and by a sloping acetabulum. The interval between the femoral head and the medial acetabular wall becomes filled by a large exostosis on the medial lip of the femoral head and, to a lesser extent, by a deposit of bone on the acetabular side. It is this deposit in concentric rings and the sloping acetabulum which give rise to the impression of a "wandering acetabulum."

Such a picture will evolve on the basis of a variety of unrelated and often dissimilar lesions which primarily affect the femoral head and/or acetabulum. On the other hand it may be observed in the absence of intrinsic disease of the femoral head. The work of Wiberg indicates that the pathogenesis in some of these cases is related to a primary hypoplasia of the acetabular roof. Those instances with normally developed acetabula represent the primary type of degenerative arthritis of the hip joint.

Many varied and often unrelated conditions involving the hip joint produce identical late changes. Hence, study of earlier roentgenograms is necessary in each case of advanced osteoarthritis of the hip in order to determine the background and pathogenesis. Such an analysis has a direct bearing on evaluation of methods for treating these pre-existing lesions of the hip, particularly in relation to the prevention of secondary degenerative changes.

Fourteen roentgenograms

W. H. SOMERS, M.D.
Indiana University

Eosinophilic Granuloma of Rib. Sandy B. Carter. J. M. A. Georgia **41**: 17–18, January 1952.

A case of solitary eosinophilic granuloma of the rib is reported. The patient was a woman forty-two years of age, though eosinophilic granuloma occurs more frequently in men and is said to be extremely rare after the age of twenty-five. A solitary nodule in the left lobe of the thyroid suggested strongly the possibility of cancer with metastasis to the rib. A left lobectomy of the thyroid was performed; the histologic diagnosis was thyroid adenoma. The segment of the rib containing the lesion was removed and histologic examination revealed eosinophilic granuloma.

Two roentgenograms.

Osteochondritis Dissecans with Spontaneous Healing. Robert E. Van Demark. J. Bone & Joint Surg. **34-A**: 143–148, January 1952.

In growing children with osteochondritis dissecans, revascularization of the undisplaced bone fragments and healing of the process occur fairly rapidly in certain cases under conservative treatment consisting in protection from weight bearing. Two cases are presented, occurring in boys eleven and thirteen years of age, involving the knees. The histories and roentgenographic findings were those of osteochondritis dissecans without evidence of displacement of the bone fragment. Use of crutches and prohibition of weight bearing resulted in apparent clinical and roentgenologic healing within six months in one case and within twelve months in the other.

The author concludes that the findings in these cases suggest that in children with osteochondritis dissecans, conservative treatment should be carried out for at least six months, surgery being reserved for those cases in which improvement cannot be demonstrated or in which displacement of the fragment occurs.

Eighteen roentgenograms.

RICHARD P. STORRS, M.D.
Syracuse, N.Y.

An Unusual Form of Osteo-Arthropathy Present Bilaterally in the Knees of Two Brothers. James D. Rogers and William H. Bickel. J. Bone & Joint Surg. **34-A**: 135–143, January 1952.

This is a report of an unusual destructive process which developed in both knees of two brothers. The onset in each case was at approximately fourteen years of age. The clinical manifestations were swelling due to effusion, instability, lateral dislocation of the patella, valgus deformity of the knees, and slight limitation of flexion. Pain was moderate in one case and absent in the other. Roentgenograms revealed roughening and fragmentation of the distal femoral epiphyses. On serial examination progressive destructive changes were noted over a two- to three-year period, following which stabilization of the process occurred. One case showed similar changes in a tibial condyle. Both patients were operated upon and in each surgery showed thickening of the synovial membrane with pannus formation and loosening of the cartilaginous surface of the lateral femoral condyle

together with a portion of the subchondral bone. There were fragmentation of the cartilage and formation of loose bodies.

Laboratory examinations, including a study of synovial fluid, revealed nothing of significance. Histologic studies of the synovial membranes suggested rheumatoid arthritis and villous synovitis, but the findings were also consistent with traumatic synovitis. Neurologic study was done because the extensive bone changes without significant pain suggested neuropathic joints, but no neurologic abnormality was found.

The authors felt that the process present in these patients was an interference with the normal maturation of the cartilage of the femoral condyles. Similarity to osteochondritis dissecans is suggested, but the exact classification of the pathologic process was considered difficult. Mention is made of a third brother in whom serial roentgenograms indicate that the same condition is developing.

Twenty-one roentgenograms; 5 photographs.

RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Osteogenic Sarcoma of the Finger. Charles E. Clark. Am. J. Surg. **83**: 112–114, January 1952.

A case of osteogenic sarcoma involving a phalanx, believed to be the sixth such tumor recorded, is presented.

In June 1947, a 37-year-old colored woman was seen in the clinic, complaining of tenderness and the sensation of a mass in the anterior surface of the distal end of the index finger. Examination showed no particular abnormality but roentgenography revealed a fracture without displacement through the very tip of the terminal phalanx. The patient failed to report for treatment, but about a year later was seen in the emergency room, complaining of gradual swelling and tenderness at the tip of the finger. There was a circumscribed swelling approximately 1 cm. in diameter on the anterior surface of the distal phalanx. This felt cystic but nothing could be obtained on attempted aspiration. Roentgen examination the next day showed a large exostosis arising from the tip of the terminal phalanx and extending down into the soft tissues of the pulp. Admission to the hospital was advised but it was ten weeks later before the patient accepted. At this time the swelling extended proximally over the middle phalanx and was much larger. The mass in the distal phalanx appeared lobulated, and to different observers it seemed cystic, fluctuant, and to transilluminate light. It was fixed to the underlying structures. Roentgenography revealed soft-tissue swelling on the anterior aspect with rather marked irregular calcium deposits. There was some destruction of the distal end of the terminal phalanx. No periosteal reaction was observed. A biopsy established the diagnosis of osteogenic sarcoma, and the finger was amputated through the carpometacarpal joint. The patient was well and apparently free of recurrence two and one-half years after surgery.

Two roentgenograms; 2 photographs; 2 photomicrographs.

Roentgenographic Study of Synovioma. Robert S. Sherman and Florence C. H. Chu. Am. J. Roentgenol. **67**: 80–89, January 1952.

Only a few articles dealing primarily with the roentgen diagnosis of synovioma have been written, and these have usually been based upon a relatively few cases. A group of 32 cases studied at the Memorial Hospital (New York) is presented here, in each of which at least one satisfactory roentgen examination was obtained.

One of the most constant features of synovioma was found to be its close association with a joint. Eleven of the synoviomas were located about the knee, 6 were found in the foot, 4 in the wrist, 4 in the hip, 3 in the hand, 2 in the shoulder, and 1 each in the ankle and elbow.

The presence or absence of effusion could be determined with assurance only so far as the knee was concerned. The evidence indicates that synovioma exists as a solitary tumor unaccompanied by any general synovial reaction such as fluid, thickening, or multiple nodule formation.

Osteoporosis, never very pronounced, was noted in 10 of the 32 cases. Three of these 10 cases showed bone destruction and in 1 of this number there was an associated periosteal reaction.

The internal pattern of synovioma was that of a homogeneous, structureless mass of water density. This uniformity of texture unbroken by any alteration seemed to be a rather constant feature and one considered useful in differential diagnosis from other soft-tissue tumors. Only 3 of the 32 synoviomas showed calcification, and in these cases only a few very small flecks of calcium were apparent.

In summary, it was noted that most tumors arising in the soft tissues could be separated from synovioma roentgenologically, either because of their own peculiar characteristics or because of their tendency to be located outside the joint areas.

Ten roentgenograms.

H. GRIFFITH, M.D.
Indiana University

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography in Female Infertility: A Comparison of Lipiodol and Viskiosol Six. Derek Freeth. Lancet **1**: 15–19, Jan. 5, 1952.

The results of salpingography in 100 cases in which Viskiosol Six (50 per cent diodone with 6 per cent polyvinyl alcohol) was used as the contrast medium are compared with those in 100 cases in which the contrast medium was Lipiodol. In the 100 cases in which the water-soluble medium was used the following conditions were found: bilateral tubal patency, 69; unilateral tubal patency, 17 (4 after ectopic gestation); bilateral cornual block, 6; bilateral fimbrial block, 8. In 13 of the 69 cases of bilateral tubal patency, and in 1 of the 17 cases of unilateral patency, previous gaseous insufflation had shown the tubes to be blocked. In the group in which Lipiodol was employed, the following conditions were found: bilateral tubal patency, 62; unilateral tubal patency, 14 (2 after ectopic gestation); bilateral cornual block, 10; bilateral fimbrial block, 6; right fimbrial block with left cornual block, 1. Tubal patency was doubtful in 7 cases in this series, because it was impossible to determine with certainty from the x-ray films whether a shadow represented an oil pocket in the peritoneal cavity or trapped oil in an occluded tube. An aqueous medium, on the other hand, shows a characteristic pattern in peritoneal spill, and there is delayed absorption of the Viskiosol Six in tubal occlusion of the fimbrial and isthmal types.

There is no evidence to suggest that Viskiosol has any toxic effects, and in the author's series there were

no cases of pelvic infection or other ill effects. The films have proved satisfactory from the radiological aspect, and conclusive results regarding tubal patency or occlusion were obtained in all cases. The radiopacity of Viskiosol Six, although not so great as that of Lipiodol, is more than adequate. The author disagrees with Williams (Lancet **2**: 151, 1949. Abst. in Radiology **54**: 916, 1950) that iodized oils are preferable for demonstrating deformities of the uterus. Serial films at fifteen-minute intervals show that in normal cases absorption of the medium takes about half an hour and is complete in an hour. Delayed absorption is pathognomonic of hydrosalpinx, and films up to three hours should be taken when this condition is suspected. The distribution of pain experienced during injection bore no constant relationship to the site of tubal blockage.

Pelvic Shape and Its Relation to Midplane Prognosis. D. Frank Kaltreider. Am. J. Obst. & Gynec. **63**: 116–121, January 1952.

This paper is based upon a group of 1,169 patients in whom x-ray pelvimetry was done between July 1, 1947, and July 1, 1950. Most of the studies were on women with clinically suspect pelves. The author points out the difficulty in classifying pelves according to the four parent types: gynecoid, anthropoid, android, and platypelloid. Figures from seven clinics are quoted to indicate how the ratio of types varies in different reports. In the present group more pelves were classified as anthropoid than as gynecoid (39 to 31.5 per cent).

The interspinous diameter of the midplane was correlated separately with its anteroposterior and posterior sagittal diameters. Scattergrams were constructed, and the percentage of difficult labors for various measurements was calculated. Difficult deliveries were defined as those in which there was difficulty with rotation, in which excessive traction was used, in which the baby showed evidence of intracranial injury or was stillborn because of the pelvis, or in which section was performed for midplane obstruction after a trial of labor.

It was concluded that an interspinous diameter of 9.0 cm., an anteroposterior diameter of 12.0 cm. and a posterior sagittal diameter of 4.6 cm. may be borderline. Further analysis of the tabulations led to the conclusion that patients with pelves of any shape or size may have trouble in the midplane. This may be expected in 4.5 of patients in whom all diameters are above borderline; in about 10 per cent in whom either the anteroposterior or posterior sagittal is below borderline and the interspinous above borderline; in about 35 per cent of patients with the interspinous diameter below borderline, no matter what the other diameters are. An interspinous diameter which is below borderline may be more dangerous in gynecoid and platypelloid pelves than in android and anthropoid pelves.

Six charts; 3 tables.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Fetal Death Diagnosed Roentgenographically by the Presence of Gas in the Fetal Circulatory System. Case Report. Kalevi Kettunen. Acta radiol. **37**: 81–84, January 1952.

The roentgenographic diagnosis of intra-uterine fetal death by the demonstration of gas in the fetal circulatory system was first described by Roberts in 1944 (Am. J. Roentgenol. **51**: 631, 1944) and then by Davidson in 1949 (Am. J. Roentgenol. **62**: 837, 1949. Abst. in Radiology **55**: 789, 1950). The author presents a case history of a thirty-six-year-old Rh-negative woman in whom examination showed an apparently full-term fetus but absence of fetal heart sounds. Spalding's sign was negative but a left lateral roentgenogram of the abdomen clearly demonstrated gas in the great vessels of the inferior extremities and in the heart. The diagnosis of fetal death was later substantiated and found to be due to erythroblastosis.

The origin of the gas in the fetal circulatory system is not yet understood. Davidson attributed it to the decomposition of blood elements. The author suggests the possibility of the Rh factor as a source of the gas.

Along with the work of Roberts and Davidson, this report indicates that the radiographic recognition of gas in the fetal circulatory system is an important contribution to the radiologist's armamentarium in diagnosing fetal death. The author emphasizes the importance of a lateral view for demonstration of the gas.

Three roentgenograms.

W. H. SOMERS, M.D.
Indiana University

THE GENITOURINARY SYSTEM

Nephrocalcinosis. Mark M. Schapiro, Jose R. Duron, and Alfredo Midence. Am. J. Surg. **83**: 26–31, January 1952.

Two cases of diffuse nephrocalcinosis occurring in a mother and her 18-year-old son are reported. The physical findings, clinical symptoms, and biochemical changes were minimal in both instances, although the roentgenologic changes were extreme in the mother and moderately advanced in the son. These are apparently the first recorded cases of nephrocalcinosis in two members of the same family. The authors believe that some familial or hereditary factor played a role in the development of the disease in these patients.

Six roentgenograms.

Roentgenographic Signs of Tumor Infiltration of the Wall of the Urinary Bladder. C. Franksson and K. Lindblom. Acta radiol. **37**: 1–7, January 1952.

In order to plan a surgical approach to growths of the urinary bladder it is important to know the extent and degree of invasion of the tumors. The purpose of this paper is to show the additional information which may be obtained on this point by roentgenography. It includes a study of the thickness of the bladder wall in the region of the tumor as well as of the emptying of the ureters.

Cystography was performed in 117 cases of bladder tumor. A definite thickening of the wall occurred only in the presence of tumors infiltrating the submucosa or deeper. Absence of thickening of the wall indicated involvement of the mucosa only. Ordinary cystograms were sufficient to determine the thickness of the upper or lateral walls of the bladder. In a few cases a tumor bulging into the peritoneal cavity could be demonstrated by outlining the peritoneal surface of the bladder by pelvigraphy with a peritoneal in-

jection of Perabrodil mixed with novocain or by distention of the sigmoid colon with air or barium. Tumors of the anterior wall were studied directly, aided by the outline between the bladder wall and the prevesical fat, or indirectly by infiltration of the prevesical fat with 35 per cent Perabrodil and 1 per cent novocain.

In those cases in which the external contour of the bladder was not visualized, a roentgenographic diagnosis of infiltration could usually be made by examining the internal contour. If this outline was elevated and then gradually returned to normal, a definite sign of at least submucosal infiltration was considered to be present.

Out of the 229 cases examined by urography a dilatation of one or both ureters or an absence of excretion was found in 58 cases. The large majority of the cases with dilated ureters showed deeply infiltrating tumors.

Histologic studies demonstrated that a benign tumor of the mucosa had little tendency to involve the mucosa of an adjacent ureter. On the contrary, malignant tumors did not respect the ureteric wall, but narrowed the lumen by growing into it.

Nine cystograms; 2 photomicrographs.

H. GRIFFITH, M.D.
Indiana University

TECHNIC; CONTRAST MEDIA

A Simple Radio-Opaque Screen for Angiography. Gordon L. Smiley. J. Neurosurg. **9**: 107–108, January 1952.

A flexible lead rubber screen has been devised which reduces exposure to radiation during angiography. A 20-inch square leaded rubber apron is fashioned with a deep inverted U-shaped cutout at its lower edge so as to drape snugly over the mandible, alongside the neck, and down to the surface of the x-ray table. The apron is clamped between steel bars along its upper edge and is suspended from a horizontal cantilever boom by a sliding hook which permits both lateral and rotary adjustments. The boom is mounted on the wall adjacent to the x-ray table.

One drawing. HOWARD L. STEINBACH, M.D.
University of California

A Practical Method of Vertebral Angiography. N. O. Ameli. Brit. J. Surg. **39**: 327–330, January 1952.

A technic for visualizing the vertebral and basilar arteries by injecting an opaque substance into the common carotid artery, in the reverse direction to the blood flow, is described. The right common carotid is used while pressure is applied to the subclavian and the carotid distal to the site of injection.

A description of the normal vascular anatomy outlined by this method is presented. Two cases are reported and 11 others in which the method was of value in clinical investigations are briefly mentioned.

Four roentgenograms; 5 drawings; 1 photograph.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

A Simple Device for Position Determination During Myelography. I. Melbourne Greenberg. J. Neurosurg. **9**: 108–110, January 1952.

An apparatus is described which automatically registers on the film the direction and degree of table angulation during the process of myelography. It consists of a freely moving ball bearing and a sealed pathway between two inverted protractors. This is applied by adhesive tape to the underside of the fluoroscopic screen. The angles of inclination are indicated by lead numbers marking the divisions between zero and 90 degrees to either side. The apparatus is made of lucite.

Three roentgenograms; 1 diagram.

HOWARD L. STEINBACH, M.D.
University of California

Modifications of the Splenic and Portal Circulation Following Ligation of the Splenic Vein. An Experimental Phlebographic Study. L. Campi and S. Abeatici. Radiol. med. (Milan) **38**: 1–9, January 1952. (In Italian)

The authors have developed a technic for the experimental visualization of the portal system by means of the rapid intrasplenic injection of a contrast medium.

Under general anesthesia they performed ligation of the main tract of the splenic vein or ligation of the hilar veins of the spleen in dogs. The portal system was studied with contrast material one, five, ten, and twenty days following the operation. The radiographs showed a very rapid re-establishment of the venous circulation following ligation of the splenic vein, while a less rapid but adequate re-establishment of the venous flow followed ligation of the hilar veins of the spleen.

Radiographic visualization of the portal system with this technic is excellent and it seems that this method should offer good possibilities for further experimental work.

Eight roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

The Tonometer, an Auxiliary Device for the Tomograph. W. Rubin. Schweiz. med. Wchnschr. **82**: 39–40, Jan. 12, 1952. (In German)

The greatest obstacle to accurate laminagraphy of the lung is the inability of the patient to assume the identical respiratory position for the exposure of each level. Also, for comparison of different follow-up laminagrams of the same patient a constant respiratory position is desirable.

The author describes an electric gauge which records the position of the sternum of the patient relative to the table top of the x-ray machine. This distance can be read on a galvanometer which is built into the control stand of the x-ray machine. The technician activates the exposure button only when the needle of the galvanometer points at the desired respiratory position.

It is claimed that this method enables one to take laminagrams of the lungs at intervals of 0.25 cm.

Eighteen tomograms; 2 drawings.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Effects of Intracarotid Diodrast. Eldon L. Foltz, L. B. Thomas, and A. A. Ward, Jr. J. Neurosurg. **9**: 68–82, January 1952.

The adverse effects of intracarotid Diodrast on the brain seem to be twofold: first, a direct vascular effect and, secondly, a neuronal or cellular effect. Initial rapid vasoconstriction followed by longer lasting vasodilatation was demonstrated visually and photographically in monkeys. Continuous recordings of spinal fluid pressure during angiography demonstrated an

initial rapid fall in pressure followed by a more prolonged rise, corresponding to the observed vasomotor changes. Electroencephalograms in both monkeys and human beings demonstrated multiple abnormalities which seem to be due to a direct toxic action of Diodrast on the neurones. Warm solutions of Diodrast produced less vasospasm than cool solutions. Unilateral stellate block also abolished the phase of vasoconstriction. After this protective vasospasm was minimized by either of these means, intracarotid Diodrast produced far greater abnormalities in the electroencephalogram. Electrocardiographic or pulse rate abnormalities were routinely produced in both monkeys and in man during angiography. These seem to be the result of central nervous system changes.

Nine figures. HOWARD L. STEINBACH, M.D.
University of California

A New Type of Accident Due to Use of Hydrosoluble Contrast Substances in Bronchography. Victor Parchet. J. de radiol. et d'électrol. **33**: 27–29, 1952. (In French)

The immediate complications encountered in bronchography are usually due to overdosage of or hypersensitivity to anesthetic agents. Even though a more careful anesthesia is required when using water-soluble contrast media, reasonable care will prevent serious effects. The author has used Ioduron B for over two years and frequently has noticed a certain degree of cyanosis and tachypnea at the close of the examination. This usually resolves with absorption and expulsion of the medium.

In one 49-year-old male the evolution was more dramatic. This patient was admitted for study of suspected polycystic disease of the lungs. Bronchoscopy revealed only a diffuse hyperemia of the bronchial mucosa. About 4.5 cg. of pontocaine was employed during anesthesia. An attempt was made to fill the right bronchial tree, but although 30 c.c. of Ioduron B was used the lower lobe could not be filled satisfactorily. The patient had difficulty coughing, respiratory excursion was slight, cyanosis appeared and deepened, and definite dyspnea ensued. During emergency bronchoscopy some 120 c.c. of a gelatinous material was removed from the left main bronchus and the principal right bronchi. Immediate relief ensued. It is suggested that thorough aspiration to eliminate secretions from the bronchial tree before bronchography might prevent such an incident.

Four roentgenograms; 1 photograph.

CHARLES M. NICE, M.D.
University of Minnesota

Radioautography in Cancer. Patrick J. Fitzgerald. Cancer **5**: 166–194, January 1952.

A review of the literature on the autoradiographic technic and its application to a variety of biological problems, some directly related to the field of cancer and others more pertinent to basic research. The problems of technic, limitations, use with allied procedures, and the future possibilities of radioautography are to be reported later.

A bibliography of 267 references is appended.

Seventeen autoradiographs.

RADIOTHERAPY

The Betatron In Cancer Therapy. Part I. T. A. Watson and C. C. Burkell. J. Canad. A. Radiologists **2**: 60–64, December 1951.

The use of a 25-mev betatron for the treatment of malignant disease was begun at the University of Saskatchewan in March 1949. It had previously been found that the biological effectiveness of 20-mev x-rays was considerably less than that of 200-kv. x-rays.

While Stone (Am. J. Roentgenol. **59**: 771, 1948) has spoken strongly against the use of high-energy radiations in man until a great deal of biological experimentation has been carried out, his conclusions were based upon particulate radiation (neutrons), which produces a very high linear ion density, and the authors do not believe that the dangers against which he warns exist in the employment of x-rays of the order of 20–25 mev, since their linear ion density is quite close to that of radium gamma rays. Further there is evidence to show that the induced radioactivity with 22-mev x-rays accounts for only about 0.01 per cent of the total ionization produced, and neutrons in the primary beam account for only about 0.001 per cent of the ionization, all of which is considered negligible.

A fixed horizontal beam is employed in conjunction with a treatment couch which can be tilted to various angles. With 22-mev x-rays the maximum dose falls at a depth between 3 and 5 cm., whereas the surface of the skin receives very little (estimated to be at about 15 per cent). Because isodose curves obtained from the betatron show a pointed appearance, indicating that the dose in the center of the field is very high but falls off rapidly toward the sides, Johns developed a copper compensating filter which flattens the isodose curves and thus renders the radiation therapeutically practicable. It is noted that x-rays of this energy produce almost the same ionization whatever tissue is traversed, and hence there is no tendency for greater bone or cartilage necrosis as with ordinary x-rays. It has further been shown that for 22-mev x-rays the integral dose received when a given volume of tissue inside the body is raised to a certain dose is in general less than one-half that received when 400-kv. x-rays are used. It is of interest, though not of major importance, that the exit dose is always larger than the entrance dose.

The output, with the compensating filter, is between 50 and 100 equivalent roentgens per minute at a focal skin distance of 105 cm. An integrating iometer monitoring device must be used since the output of the machine varies erratically with changes in injection and contraction timing.

The authors have adopted the convention of stating their dose as the maximum dose received at 4 cm. depth. They have adopted a figure of 40 per cent as representing an approximate effective entrance skin dose.

Approximately 75 patients suffering from advanced malignant disease have been treated. The first 61 patients were treated over a period of three weeks, whereas the remainder were treated over a period of five weeks, five times weekly.

Of the 75 patients treated, 9 are omitted because they were too recently treated and 8 are excluded because their treatment was not completed, leaving a total of 58 patients for consideration. At the time

of the report 26 of these hopeless patients were alive and 32 dead.

In no patient did radiation sickness develop, nor were any significant hematologic effects observed. The local tissue reactions were found to be the limiting factors in dosage (such as diarrhea and/or urinary frequency). Most patients showed no erythema; and dosage levels in patients with pelvic carcinoma were gradually raised to 6,000 r in a period of three weeks, while in patients with thoracic carcinoma a dosage of 6,500 r in a period of three weeks was employed. With these maximum dosages the constitutional reactions were occasionally so severe that hospital care with intravenous feedings was necessary to tide the patient over the reaction phase.

This dosage level was found in a majority of patients to cause disappearance of the tumor, but unfortunately there was often a local recurrence, indicating a failure of treatment from inadequate dosage. With this in mind, the over-all time was increased to five weeks and the tumor dose increased to 7,500 r; but again the limiting factor was the local tissue reaction. Doses approximately four-fifths that given for carcinoma of the lung or pelvis were adopted for neurological tissues. Thus, within a three-week course of treatment a dose of 5,500 r was employed; and with the five-week course a dose of 6,000 r was used.

See following abstract. I. MESCHAN, M.D.
University of Arkansas

The Betatron in Cancer Therapy. Part II. T. A. Watson and C. C. Burkell. J. Canad. A. Radiologists **3**: 25–28, March 1952.

This paper is a continuation of that abstracted above, reporting the results of therapy at the University of Saskatchewan with 2-mev x-rays in 58 patients with far advanced malignant disease, including tumors of the cervix, bladder, lung, rectum, brain, esophagus, and a miscellaneous group. None of the patients was treated with the electron beam. The skin dose ranged from 1,800 r to a maximum of 4,300 r and the tumor dose from 3,500 to 7,500 r in seventeen to thirty-three days.

The average period of follow-up was well under a year and in only one instance does it seem to have been as long as seventeen months. Some favorable immediate results were obtained in carcinoma of the cervix and urinary bladder, and in brain tumors. Little effect was seen in rectal carcinoma. On this rather slim evidence, the betatron is considered to be a practicable deep therapy machine.

One drawing. THOMAS H. WOLEVER, M.D.
The Henry Ford Hospital

Directed Beam Therapy. A Rotational Therapy Chair. Bertram V. A. Low-Beer. Am. J. Roentgenol. **66**: 956–960, December 1951.

The attempt to deliver the greatest possible radiation dose to the tumor and smallest possible dose to surrounding tissues has led to increasing the generating potential, the filtration of the roentgen-ray beam, and the target-skin distance. Direction of the radiation beam toward a deep-seated tumor through multiple skin portals or rotatory irradiation most nearly approaches a solution of the problem by centering the rays on the lesion which lies in the point of beam convergence or axis of rotation. In rotatory irradiation, the axis field is continually irradiated, whereas all points situated outside the axis field are exposed to radiation only during the time that the beam passes through that segment of tissues.

This report describes a specially designed treatment chair for rotational therapy which facilitates (1) complete rotation at various speeds, (2) partial rotation or oscillation, and (3) linear reciprocal motion.

A position indicator for insuring accurate beam direction is described. The position indicator registers at the technician's control desk any motion of the patient exceeding 1/32 of an inch.

Three figures. THOMAS S. LONG, M.D.
University of Louisville

Pathology and Classification of Tumors of the Soft Tissues. Arthur Purdy Stout. Am. J. Roentgenol. **66**: 903–909, December 1951.

Tumors of the soft tissues have been called sarcomas in the past and generally badly treated. There are 66 soft-tissue tumors, 44 benign and 22 malignant. Only in the case of Kaposi's disease can one make an accurate clinical diagnosis.

The commonest of the malignant tumors in this group is fibrosarcoma, which, although it is described in the literature as an exceedingly malignant and fatal neoplasm, may be neither. The author presents a listing of 218 cases from the Laboratory of Surgical Pathology, Columbia University. Of these, 145 were followed: only 10 tumors were known to have metastasized and only 25 patients were known to have died of the tumor. The author divides the fibrosarcomas into two distinct groups according to the amount and thickness of the connective tissue fibers formed, the degree of resemblance of the tumor to proliferated scar tissue, and the relative number of mitoses. If differentiation is good, the fatalities are few and due solely to the eventual effects of unchecked infiltrative growth.

The recurrence rate of 61 per cent for all tumors of soft parts shows that poor treatment has been the rule. The tumors which are somewhat radiosensitive are Kaposi's disease, reticulum-cell sarcoma, lymphosarcoma, and plasmocytoma. Chances for cure are remote except for reticulum-cell sarcoma and lymphosarcoma.

Five tables. THOMAS S. LONG, M.D.
University of Louisville

Glomus Jugulare Tumor. David M. Gibson and G. O'Neil Proud. J. Kansas M. Soc. **52**: 581–583, December 1951.

Twenty-one definite and 13 probable cases of glomus jugulare tumor have been recorded in the literature. [For a case published since this compilation, see Land: Radiology **59**: 70, 1952.—Ed.] The previous reports show no agreement as to the radiosensitivity of this neoplasm.

In the present case mastoidectomy was attempted because of the presence of a large vascular polypoid growth in the left ear canal. Excessive hemorrhage made completion of the operation impossible, and a course of x-ray therapy [the only factors stated are "3,364 r in fifteen days"] was given. Two months later the growth was much smaller and less vascular, allowing complete removal. It was only after this operation that the correct diagnosis was made. The

tumor had involved the eustachian tube, the wall of the facial canal and of the carotid artery, and the semicanal of the tensor tympani, as well as the external ear canal.

Two photomicrographs. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

The Artificial Menopause and Cancer of the Breast. A. Hochman. J. Fac. Radiologists **3**: 199–202, January 1952.

An artificial menopause was induced by irradiation in 60 women with cancer of the breast and its metastases. Thirty-four of these women, or 56 per cent, benefited from the treatment. Adenocarcinoma corresponding to Grades I and II of Broders' grading was the most susceptible to this treatment. Anaplastic carcinoma of the breast, carcinoma simplex, corresponding to Grades III or IV, was less susceptible to the estrogen-inhibiting influence of the artificial menopause. Less than 1 per cent of this group benefited from the treatment.

It may be that in carcinoma simplex the marked deviation of the cells from normal function accounts for the lack of response to withdrawal of estrogenic substance. THOMAS S. LONG, M.D.
University of Louisville

Primary Lymphosarcoma of the Stomach. George Crile, Jr., John B. Hazard, and Kenneth L. Allen. Ann. Surg. **135**: 39–43, January 1952.

An analysis of 19 cases of lymphosarcoma of the stomach treated at Cleveland Clinic during 1935–50 has shown the prognosis in this disease to be much more favorable then in carcinoma of the stomach. Thirteen of the patients (85 per cent) are living without recurrence six months to twelve years after operation, with an average survival of five years. Of the remaining 6, 4 did not survive operation (before 1945), and 2 died of other causes four years and ten years after operation.

The relative merits of surgery and x-ray therapy could not be analyzed in this series, since 13 of the 15 surviving patients received both forms of treatment. The recommended treatment is "gastric resection followed by irradiation, or irradiation only if the lesion is not resectable."

The roentgen examination sometimes reveals helpful signs such as (1) a filling defect with smooth margins, (2) thick folds of mucosal rugae, and (3) multiple ulcers, but these are not diagnostic. Gastroscopy was performed in 8 of the cases considered here, and in only 1 was lymphosarcoma diagnosed.

The authors feel that since the clinical picture of lymphosarcoma and carcinoma is so similar, there is no basis for determining the prognosis unless a biopsy is obtained. Empiric trial of roentgen therapy may be used if it is felt that the patient cannot tolerate a biopsy, but such cases are rare, and roentgen therapy with no biopsy information does not otherwise seem justified. D. D. ROSENFELD, M.D.
Fontana, Calif.

Present Day Methods of Treatment of Carcinoma of the Cervix. H. Dabney Kerr. South M. J. **45**: 47–50, January 1952.

Recently more articles concerning the advisability of surgery in selected cases of cervical carcinoma have been appearing. One disadvantage of this trend is that, despite the warnings of the authors that such surgery is experimental in nature, it increases the number of inadequate operations performed by surgeons poorly qualified for this type of work. A beneficial effect is that the radiologist is stimulated to better efforts in order to achieve the maximum benefits of radiation therapy.

The author believes that there is a place for surgery in the treatment of carcinoma of the cervix in the hands of the expert. It is of value in the early case, where it is the equal but not the superior of good radiation therapy. It is useful in the care of radioresistant tumors which remain after intensive radiation therapy and in the occasional case which justifies the radical procedure advocated by Brunschwig.

The object in radiation therapy is to deliver a lethal dose to the tumor while sparing the normal tissues as much as possible. In the author's clinic 25.7 per cent of all patients treated between the years 1926 and 1937 and 37 per cent of cases treated between 1937 and 1942 lived five years without evidence of recurrence. He feels that the use of more external fields for radiation and an increase of radium dosage account for this improvement. The present system of treatment is as follows: External irradiation is begun as soon as the lesion is proved. Anterior and posterior fields 15 × 15 cm. (with the midlines protected by a 2-cm. lead strip), two lateral 10 × 15-cm. fields, and two gluteal 10 × 10-cm. fields are used. Each of two fields receives 200 air roentgens a day. The dose to the cervix and parametrium are figured separately. An attempt is made to reach a tumor dose of 4,000 roentgens in the parametrium bilaterally, at points 5 cm. lateral to the midline. When the course of external irradiation is about two-thirds completed, the local lesion is treated by radium, usually with the aid of the Ernst applicator. This timing is considered an important factor in the treatment, so that there may be a summation of the external and internal radiations.

Cutaneous reactions occur in practically every case. Proctitis is also frequent. Fracture of the femoral neck occurs in about 2 per cent of cases, but such fractures respond well to good orthopedic care.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Vaginal Applicators in the Treatment of Carcinoma of the Cervix. A. F. Sudholt, Jr. J. Missouri M. A. **49**: 29–31, January 1952.

In spite of the risk of damage to paravaginal and paracervical tissues, the author emphasizes the importance of intravaginal radium therapy for adequate treatment of carcinoma of the cervix.

He recommends that the radium application be made before external irradiation, since the vaginal diameter may be significantly reduced by the latter. This, in turn, might limit the size of the vaginal applicator and lessen the distance between the radium and treated surface.

Various vaginal applicators and methods of radium treatment are discussed. The author recommends a modified Manchester technic described by Fletcher (Radiology **54**: 832, 1950), which uses a tandem inside the uterus and vaginal ovoids of variable size and strength. He feels that a lethal dose of irradiation can be delivered to a greater volume of tissue with less risk of exceeding the tolerance of normal tissues.

A table of estimated tolerance doses for specified points in the pelvis is presented as an aid in calculating dosage requirements.

Two illustrations. ALLIE WOOLFOLK, M.D.
Pittsburgh, Penna.

Fate of the Patient with Advanced Cancer of the Cervix of the Uterus. W. G. Cosbie. Am. J. Obst. & Gynec. **63**: 108–115, January 1952.

During the years 1938 to 1947, 858 patients with cancer of the cervix sought treatment at the Gynaecology Clinic at the Ontario Institute of Radiotherapy, Toronto General Hospital. Of these cases, 535 (62 per cent) were classified as Stage III and Stage IV. It is with these 535 Stage III and IV cases that this paper deals.

The duration of symptoms was under a year in 72 per cent of the cases and over a year in 28 per cent. Vaginal bleeding was the first symptom in about two-thirds of the patients, and vaginal discharge in about one-fifth. Ten per cent of the group were in such poor general condition that treatment was not undertaken or had to be discontinued shortly after it was begun. Twenty-nine per cent of the patients were alive and well after three years, and 26 per cent (of 406) after five years. Most cases were treated by a combination of 400-kv.p. x-ray therapy through six portals and vaginal application of radium. The details of treatment are not given. X-ray therapy through vaginal cones was used in selected cases.

The author feels that retreatment of recurrences by x-ray therapy is worth while and prolongs life appreciably when the recurrence is local. Autopsies were performed on 27 of the patients in the series. Seventeen of these were found to have extrapelvic metastases. Lymph nodes, liver, and lung were the most frequent sites.

Two drawings; 6 tables.
T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Review of the Complications from Radium Treatment for Carcinoma of the Cervix Uteri. M. D. Bonebrake and Alfred I. Sherman. J. Missouri M. A. **49**: 19–23, January 1952.

This article deals with the study of 490 patients seen at the Barnes Hospital, St. Louis, between the years 1921 and 1947. These patients were all followed for five years with the exception of those treated in 1947, for whom only a four-year follow-up was possible. Complications were divided into four main groups: small bowel complications, large bowel complications, genitourinary injuries, and local reaction.

Only 2 patients of this series had small bowel complications which ultimately resulted in ulceration and fistula formation. The complications in the small bowel otherwise were confined mainly to the immediate radiation reaction.

The large bowel reactions were divided into intrinsic and extrinsic types. The intrinsic type produces symptoms during the period of radiation or shortly thereafter, including tenesmus, bleeding, burning sensations, and frequent small stools. Such complications subside in most instances within two or three weeks. In a few patients this reaction may recur as a late complication. Starch enemas and cod-liver oil instillations produce remission in most instances. The extrinsic rectal reaction is that which involves the perirectal tissues and may result in extreme stenosis. This occurred in 5 patients of this series, requiring relief by colostomy.

The immediate symptoms of injury to the genitourinary system were found to be dysuria, hematuria, and frequency of urination. The end-result of such reactions may be a benign type of hematuria, which is difficult to differentiate from that due to tumor infiltration of the bladder wall, or stricture as a result of fibrosis of periureteral structures.

The severe local reactions usually result in hyperpyrexia, pain, vaginal bleeding, and foul discharge during the period immediately after treatment. This type of reaction was found to be due for the most part to over-treatment in the tissues immediately adjacent to high-intensity sources of radium.

The authors note an increase in the number of patients with Stage I and II cancers presenting themselves for therapy, which they interpret as an indication of more careful study by the family physician as well as education of the general public. They report an overall five-year survival of 30 per cent, and a decrease in the occurrence of complications. During the period 1937–47, the incidence of complications of all types did not exceed 27 per cent. Values prior to that time ranged from 40 per cent to 65 per cent. The highest incidence occurred during the time that 75 mg. of radium were used in the cervix with a single 25-mg. tube in the uterine cavity. The decrease in incidence of complications is attributed to better use of radium and its more careful distribution, as well as more careful external irradiation.

Five graphs. PAUL R. NOBLE, M.D.
Pittsburgh, Penna.

Results of Radiotherapy (Curietherapy and Roentgentherapy) in 124 Epithelioma Cases of Stump of the Cervix, Treated from 1919 to 1944 at the Curie Foundation. Juliette Baud. J. Fac. Radiologists **3**: 203–206, January 1952.

Cure of carcinoma of the cervix is often considered more difficult when it develops on the stump after a subtotal hysterectomy performed for a non-cancerous gynecological condition. This is supposedly due to the impossibility of introducing a radium sound of normal length which would irradiate the pelvis from the uterus.

The author compares the results among patients treated at the Curie Foundation from 1919 to 1944 for carcinomas of the stump and for ordinary carcinomas of the cervix.

Among 2,688 cervical carcinomas, 124 (4.6 per cent) developed on the stump. The symptomless period lasted from four to thirty-eight years in 110 cases. In 14 cases it was possible to ascertain that no sign of cancer had been present at operation. In only 1 was purulent discharge at the cervical ostium the first sign of cancer. In these 124 patients the number of exophytic and of ulcerative types was the same.

The treatment for cervical stump carcinoma was the same as for other carcinomas of the cervix. Local radium therapy was employed with peripelvic x-ray or teleradium therapy in 98 cases. Local radium therapy alone was employed in 15 cases and peripelvic irradiation was the only treatment in 11 cases. For vaginal radium therapy a colpostat was used, with the frequent addition of a median cork and, exceptionally, addition of two independent median corks. The only difference was the absence of intra-uterine radium,

except in 28 cases (22.6 per cent) where it was possible to introduce a short radium sound in the cervical canal of the stump.

Fifty-one patients (41 per cent) were in good health from six to twenty-two years after treatment. The five-year cure rates for the different stages were: Stage I, 72 per cent; Stage II, 44 per cent; Stage III, 21 per cent. These rates are at least as good as those in the total series of 2,688 cases, which were as follows: 38.5 per cent for Stages I–IV together; 66.6 per cent for Stage I; 43 per cent for Stage II; 26.4 per cent for Stage III; 8.8 per cent for Stage IV.

The author concludes that epitheliomas of the cervical stump may be treated by the usual method of treatment with no change of prognosis resulting from the impossibility of introducing a radium sound in the cervical canal.

One table.

THOMAS S. LONG, M.D.
University of Louisville

Sarcoma of the Uterus. A Record of Twenty-six Cases. Arnold N. Fenton and Louis Burke. Am. J. Obst. & Gynec. **63**: 158–162, January 1952.

The authors review the 26 cases of sarcoma of the uterus seen on the ward gynecological service of the Mount Sinai Hospital in New York during the years 1933–1948. Sarcoma constituted 5.5 per cent of all malignant tumors of the uterus (including cervix) during that period. Fourteen of the tumors were believed to be primary sarcoma. The other 12 were thought to represent malignant change in a fibroid tumor. The youngest patient was twenty-eight years old; most of the group were over forty.

Thirteen of the patients are still living and well. However, one probably has a recurrence, and 4 have been followed less than five years. When allowances are made for these patients, the five-year survival rate is 36 per cent. Four of 8 patients treated by radiotherapy alone are living and well after five years.

Six tables.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Radiological Management of Chorio-Epithelioma. Report of Two Cases (One with Pulmonary Metastasis) with 10 Years Follow-up. Paterno S. Chikiamco. J. Philippine M. A. **28**: 32–38, January 1952.

Two cases of chorio-epithelioma, one in which the tumor was confined to the uterus and the other with pulmonary metastasis, are reported. The first patient was seen in October 1940, complaining of vaginal bleeding for fifteen days. Dilatation and curettage were performed. Histologic examination showed chorio-epithelioma. Bleeding recurred ten days later, and Friedman's test was positive. Roentgen therapy was administered for a total of 1,500 r (in air) to each of four fields directed to the pelvic region, employing a 200 r daily dose. In March 1941 the course of x-ray therapy was repeated. From January until December 1941, prophylactic irradiation was given to the lungs, with a total of 4,000 r through four fields over the chest. At the time of the report, the patient was in good health, with no evidence of recurrence.

The second patient was referred in May 1941, for radiation treatment of a uterine chorio-epithelioma with metastasis to the lungs; surgery had been refused. There was a history of vaginal bleeding and passage of a mole. Biopsy showed chorio-epithelioma. Deep x-ray therapy was administered with the following factors: 200 kv.; 0.5 mm. Al and 0.5 mm. Cu filtration; 50 cm. distance; 2 anterior and 2 posterior 10 × 10-cm. fields converging upon the uterine growth and the adjacent parametria. The daily dose was 200 r to a single field, the different fields being treated in rotation. The total dose was 2,000 r (in air) per field, and the response was favorable. From Aug. 15 until Dec. 5, 1941, 12,000 r was given to the chest, using 8 fields. X-ray examination late in November 1941 showed definite clearing of the metastatic foci in the lungs. The patient was seen at intervals and on each occasion a chest roentgenogram was normal. In July 1945, she complained of chest pain. The x-ray examination was still negative but, since there was no evidence of post-irradiation fibrosis, a total of 1,050 r was given to the chest fields. The patient was last seen in October 1951, at which time she was still free of metastasis or recurrence.

Four roentgenograms.

Chorioadenoma Destruens. C. P. Hodgkinson. Am. J. Obst. & Gynec. **62**: 1353–1356, December 1951.

Chorioadenoma destruens is recognized as a benign chorionic tumor. Controversy exists as to whether it represents a true neoplastic lesion or an exaggeration of the normal tendency of trophoblastic tissue to invade. Invasion of the myometrium, pelvic veins, and broad ligament is a characteristic feature. The failure of this tumor to metastasize sets it apart from chorion-epithelioma, which spreads to distant organs. A case in a 25-year-old woman is reported to emphasize the invasive tendencies of the placental trophoblast.

The patient was first observed in 1944, at which time an early hydatidiform mole was recovered by curettage. Five months later a hysterectomy and right salpingo-oophorectomy were performed. Examination of the excised uterus revealed a hemorrhagic nodule situated deep in the myometrium; this had eroded the outer shell of the uterus to rupture into the right broad ligament. During the time the tumor was confined to the myometrium, the Friedman reaction was strongly positive. Subsequent to a clinical episode which suggested the time when the nodule ruptured into the broad ligament, all Friedman tests became negative. Immediately following hysterectomy the patient was given a course of deep x-ray therapy, a total of 10,950 r being administered to four pelvic ports. She has now survived for five years, and there is no biological or clinical evidence of recurrence of the tumor.

One photograph; 1 photomicrograph.

Vulval Cancer: A Critical Review. William K. Diehl, Joseph W. Baggett, and James H. Shell. Am. J. Obst. & Gynec. **62**: 1209–1218, December 1951.

Because of the lack of a universally acceptable method of treating carcinoma of the vulva and the discouraging salvage rate, the authors selected 25 private and 25 service patients for a critical statistical review. They include in their discussion malignant disease not only of the labia but of the clitoris, the periurethral tissues, and Bartholin's gland.

Carcinoma of the vulva is a disease of older women, 25 of the patients in the present series being between sixty and seventy-nine years of age. Seventy-eight of the women were white, although the dispensary population at the University of Maryland, where the

survey was made, is predominantly Negro. Seven patients were single, 23 were married, and the remaining 20 were widows. Nine of the patients had not been pregnant, while the remaining 41 had had from 1 to 11 full-term children. The average parity of the group was 4.5. There were 48 lesions which arose primarily in the vulva. In 2 the lesion was one of multiple cancers, a carcinoma of the cervix being associated in each instance. Of the 48 primary neoplasms, 46 began in the vulva and 2 in Bartholin's duct. In this series pruritus was a cardinal symptom; leukoplakia and kraurosis were much less frequently noted.

Three patients received no treatment. Radiation alone was employed in 12 patients, none of whom survived five years. Local excision was the method of treatment in 13 patients; 3 of these lived more than five years and 1 was still living and well and free of evidence of cancer eighteen years later. Eleven patients were treated by combined radiation and bilateral vulvectomy; 4 patients so treated lived more than five years; one patient was symptom-free seventeen years later and two had been well over ten years. Eleven patients were treated by a modified Bassett operation, and it is thought that it offers the best means of treating carcinoma of the vulva; 6 of the patients were living and well at the time of the report, but all had been treated within the last five years.

Five illustrations; 2 tables.

Radiotherapy and Testicular Neoplasms. Geoffrey Boden and Robert Gibb. Lancet **2**: 1195–1197, Dec. 29, 1951.

Between 1936 and 1945, 128 cases of testicular neoplasm were referred to the Christie Hospital, Manchester, England. In 96 cases the tumor was a seminoma, a carcinoma of the seminal epithelium, or an embryonal carcinoma; all of these tumors are classified as seminoma. In 17 cases the histologic diagnosis was malignant teratoma, adenocarcinoma, or chorion carcinoma, and these cases are classified as teratoma. Fifteen cases were not classified. The mean age of the patients with seminoma was forty and of those with teratoma thirty-five years. In 52 per cent of the cases metastases were already present at the time of the first examination. Four patients were lost to follow-up and 3 died of intercurrent disease; all of these are counted as having died of neoplasm. With one exception, a preliminary orchiectomy was done in every instance. In no patient that survived five years was there evidence of residual neoplastic disease at the end of that period.

Seminoma: Forty of the 50 patients (80 per cent) with no demonstrable metastases and 12 of the 29 (41 per cent) with intra-abdominal metastases only were alive at the end of five years. Only 2 of the 17 patients with extra-abdominal metastases survived five years.

Teratoma: Five of the 10 patients with no demonstrable metastases and 1 of the 4 with intra-abdominal metastases were alive at the end of five years. None of the 3 patients with extra-abdominal metastases survived five years.

Unclassified Tumors: Only 3 of the 15 patients survived five years.

Simple orchiectomy was successful in eradicating the testicular tumor in only 25 per cent of early cases. Simple orchiectomy followed by x-ray therapy was successful in 49 per cent of all cases. In early cases of seminoma a five-year survival rate of 80 per cent was obtained by the combined method but the results in teratoma were less favorable.

In the authors' opinion, every patient with testicular neoplasm should be given x-ray therapy immediately after orchiectomy, irrespective of the nature of the tumor and the presence or absence of metastases.

Five tables.

Leukaemia in Children. C. L. Rodgers, W. L. Donohue, and C. E. Snelling. Canad. M. A. J. **65**: 548–552, December 1951.

One hundred and fifty-eight cases of leukemia seen in the Hospital for Sick Children, Toronto, in patients under the age of fifteen, are reviewed. Over 90 per cent of the patients in this series had the acute fulminating type of leukemia with an average duration of life from the onset of the symptoms of less than three months. Approximately 7 per cent of the cases were classified as subacute, with an average survival of more than twelve months. Only 2 cases were diagnosed as chronic granulocytic leukemia.

The final diagnosis of leukemia was established on the basis of peripheral blood findings, sternal marrow punctures, biopsy, and autopsy, either singly or in combination. Roentgenograms of the long bones were taken in 38 cases and, of these, 18 showed definite abnormalities such as periosteal elevation and a zone of rarefaction at the diaphyseal side of the epiphyseal plate.

Twelve patients were given x-ray therapy. Except for a reduction of the white blood count and a decrease in the size of enlarged lymph nodes, liver, and spleen in some cases, it is not felt that this treatment materially affected the course of the disease. Subsequent courses of therapy proved to be less effective than the first.

Two patients were treated with radioactive phosphorus. In one case the white count went from 200,000 to 24 cells. At no time was there evidence of clinical improvement. The patient died eighteen days after therapy and postmortem there was evidence of destruction of leukemic cells. The other patient died five days after the termination of treatment with no appreciable clinical or hematologic effect.

No effect was achieved in one case treated with Urethane.

Eleven patients were treated with pentnucleotide. In one case, the blood count fell from 14,000 to 400 cells in eight days, with death two days later. No effects of the drug were noted in other cases.

All of the patients had anemia, either on admission or later during the course of the disease. One hundred and twenty-four received transfusion for palliation. This temporary measure was the most effective type of treatment.

Five graphs.

MASON WHITMORE, M.D.
Jefferson Medical College

Orbital X-Ray Therapy of Progressive Exophthalmos. Arthur Jones. Brit. J. Radiol. **24**: 637–646, December 1951.

Progressive exophthalmos is a disease entity not clearly defined. It is predominantly a disease of middle life. It may arise spontaneously or follow thyroidectomy. It is not the same as the ordinary exophthalmos seen in Graves' disease but is rather a special ophthalmopathic variety of the latter condition.

The history is that of progressing discomfort in the orbit, prominence of the globe, and diplopia. It may be unilateral or bilateral. When it appears after thyroidectomy, it is usually on a basis of preceding exophthalmos associated with the thyrotoxicosis.

Pathologically there is lymphocytic, monocytic, and plasma-cell infiltration of the ocular muscles and edema of the orbital structures. If the lesion is of long standing, there may be extensive fibrosis.

High-voltage radiation, h.v.l. 1.3–1.85 mm. Cu, in doses of 1,000 r in fourteen days was given in 29 cases of progressive exophthalmos, of which 22 were not associated with thyrotoxicosis and 7 were. Of the 22, 2 had malignant exophthalmos and 20 chronic progressive exophthalmos. The 2 lesions of the malignant type responded excellently. In the 20 cases of chronic disease, regression was complete to moderate in 9, slight in 7, and absent in 3. The 7 thyrotoxic cases responded poorly.

In one patient, a man sixty-six years old with severe bilateral exophthalmos with keratitis, cataract developed eighteen months after treatment. No cases of uveitis or chronic conjunctivitis occurred.

Eight photographs; 2 photomicrographs.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Black Hairy Tongue. Report of a Case Cured with Superficial Roentgen Radiation. D. Truett Gandy. Arch. Dermat. & Syph. **65**: 97–98, January 1952.

A case of black hairy tongue, of unknown duration, was treated with unfiltered roentgen rays through a cone with 1-in. (2.54 cm.) port, the beam being directed at the base of the triangular mass in the "V" formed by the circumvallate papillae. The growth disappeared in ten days and had not recurred after two years.

One illustration.

Thymic Tumour Associated with Myasthenia Gravis, with Special Reference to the Effects of X-Ray Therapy. I. G. Williams. J. Fac. Radiologists **3**: 176–185, January 1952.

There is no doubt that myasthenia gravis is in some way associated with the thymus gland. The gland itself may be smaller than normal, may be hypertrophied, or may be the site of a tumor. Removal of the gland in many cases results in relief of the myasthenia.

In about 10 per cent of cases of myasthenia gravis there is an associated tumor of the thymus gland. Such tumors are benign, although they may recur after removal or may spread within the thoracic cage. In many other cases lymphoid germinal centers in large numbers may appear in the gland. However, the disease may also occur with no detectable change in the thymus itself.

The author describes the basic physiology of myasthenia gravis and particularly the chemical reactions which take place at the myoneural junctions. Treatment is of two main types. The first attempts to restore the balance at the myoneural junctions by medication and the second seeks to abolish thymic activity, which appears to be related in some unknown fashion to these myoneural reactions. The latter has been accomplished by surgical removal of the gland or by means of irradiation. The author has treated by means of radiotherapy 13 cases of thymic tumors associated with myasthenia gravis. One group was given preoperative irradiation to lessen the risk of surgical removal. In another group irradiation was done as a postoperative measure when surgical removal was considered to be incomplete. A third group (4 patients) was given irradiation as a primary method of treatment.

Million-volt therapy is believed to offer considerable advantage over conventional irradiation. Treatment is carried out after preliminary administration of Prostigmin. The initial radiation dose is small. The range of tumor sensitivity is great. Improvement in the myasthenia is slower than is evidence of tumor shrinkage. Improvement may continue up to six months following therapy. The author's limit of tumor dosage is 4,000 r in four weeks. Complications have been mediastinitis and pneumonitis, but they have left no gross effects. Skin damage and subcutaneous reactions have not been too severe to prevent surgery. If radiation therapy is a primary method of treatment, it may be necessary to increase the tumor dosage to 5,000 to 6,000 r in five to six weeks.

The time following the institution of therapy has been too short for the author to evaluate its success. It would seem, however, that primary irradiation of thymic tumors in myasthenia gravis may be an acceptable form of treatment.

Eight illustrations including 1 roentgenogram.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Roentgen Treatment of Cervical Spondylosis. A Follow-Up Examination of 625 Patients. Johan Lundar. Am. J. Roentgenol. **66**: 947–955, December 1951.

The author reports on a series of 625 patients treated by irradiation for cervical osteoarthritis in Oslo, Norway, in 1945–47 and followed by means of a questionnaire. Monotonous and unbalanced work, such as knitting or package carrying, seems to incite or aggravate this condition. Roentgenograms verify the diagnosis. Most patients are between the ages of forty and sixty, and women predominate.

In 70 per cent of the series excellent results were obtained (complete relief in 30 per cent; considerable relief in 40 per cent). In all, 90 per cent received some benefit from the treatment. The results were better the earlier in the course of the disease irradiation was instituted. Recurrence was more frequent the longer the duration of the disease. There was little correlation between results and the severity of the roentgen changes.

Treatment consists of six applications of 125 r to a posterocervical field over a four-week period. A second, and in some cases a third, series is administered after a six-week interval. One-half of the patients received only one treatment series. There are no deleterious side-effects.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Snapping Finger. Roentgen Treatment and Experimental Production. W. Pagh Sperling. Acta radiol. **37**: 74–80, January 1952.

Snapping finger or trigger finger is characterized by an obstruction to flexion or extension of the finger due to a disproportion between the diameter of the flexor

tendons and that of the tendon sheaths. A constriction of the sheath and/or some irregularity of the tendon are usually present. The patient complains of irregular movements of the finger, pain on motion or attempted motion, tenderness and swelling of the flexor surface.

Thirty cases of snapping finger occurring in 26 patients treated with roentgen irradiation are presented. Irradiation was given daily or every second or third day for an initial series of two to four treatments, and in some cases a second series was given after an interval of two weeks. The number of treatments ranged from two to nine, averaging 4.5. The average period of irradiation, including intervals, was 4.5 weeks, the maximum being four months. Total dosage varied from 500 to 2,350 r, the average being 1,150 r. Single doses of 150 to 300 r were given at a distance of 30 to 40 cm., filtered with 3.0 mm. Al or 0.5 mm. Cu.

The average length of time from the first treatment to distinct recordable improvement was twenty-eight days. Twenty-one patients were completely cured both objectively and subjectively. The remainder experienced some relief of pain, swelling, and tenderness. No recurrences were encountered, and none of the patients had post-therapeutic discomfort.

The author experimentally produced a snapping finger in himself by vigorous repeated flexions of his fingers over a period of a few days.

One table. J. S. WHITMORE, M.D.
Indiana University

Free-Air and Thimble Ionization Chambers for Grenz-Ray Dosimetry. W. J. Oosterkamp and J. Proper. Acta radiol **37**: 33–43, January 1952.

The use of low-voltage x-rays has been extended by the introduction of tubes with new type windows resulting in very low inherent filtration. Particular reference is made to the beryllium window. Measurement of output is difficult not only because of the absorption in air but also because of the high dose rates.

The authors constructed a free-air chamber based on a design of Taylor and Stoneburner (Radiology **23**: 22, 1934), with some modifications in order to measure higher dose rates. Absorption in air can be determined by adjusting the position of the chamber to the focal spot and shifting the electrical system accordingly.

Thimble chambers present two problems when used for grenz ray measurement: the absorption in the wall of the chamber and the effective atomic number of the wall itself. This latter problem arises from the very nature of absorption, depending upon the quality of the radiation. Where the Compton effect is predominant, it is only slightly dependent upon the atomic composition of the material, while photo-electric absorption is proportional to the third power of the atomic number.

The authors describe two methods of making thimble chambers for grenz rays which are fairly independent of wave length. A rigid chamber can be made with relatively thick windows and wave-length independence between 0.02 and 1.0 mm. Al and between 0.04 and 2.5 mm. Al h.v.l. Wave-length independence is obtained by using for the wall a material which has an effective atomic number lower than that of air. It is possible to choose a wall thickness so that absorption by the wall is compensated by the increased efficiency obtained.

Seven illustrations. J. DURLACHER, M.D.
Indiana University

Frequency or Wave Length in Roentgen Energy Distribution Diagrams. Bo Lindell. Acta radiol. **37**: 28–32, January 1952.

The author states that energy distribution is generally shown diagrammatically as intensity per wave length versus wave length of the continuous roentgen spectrum. It can also be described by showing the relationship between the energy per frequency interval and the frequency. The maximum points on the two curves are not the same. The intensity per wave length versus wave-length curves have a maximum at wave length equal to 3/2 the minimum wave length; it is easy for one to look at this relationship and say that the energy has a maximum at 3/2 the minimum wave length. This is not a true interpretation; it is instead a measure of the energy per wave-length interval. The author suggests that if we want to know the energy distribution it is better to use the intensity per frequency versus frequency curves, since the energy is proportional to the frequency.

The curves showing relationship of intensity per wave length versus wave length have been used to show the efficiency of supervoltage as compared with gamma rays from radium. This is not correct, for the impression is given that in supervoltage most of the radiated energy is transferred by high-energy quanta, when in reality there are always present a very large number of photons of low energy. On the contrary, the gamma rays from radium are exclusively high-energy quanta.

Six graphs. J. DURLACHER, M.D.
Indiana University

A Grid Ionisation Chamber of Special Design for the Measurement of Soft Radiations. A. Somerwil. Acta radiol. **37**: 44–48, January 1952.

The main problem of grenz-ray standard dosimetry with a free-air parallel-plate chamber of usual pattern lies in the absorption in air, so that the beam leaving the ionization measuring volume has an intensity appreciably less than that due to the inverse-square law. In the second place great intensities will demand strong electric fields to cause saturation.

The author describes an ionization chamber constructed on the combined principle of the extrapolation chamber and the mesh chamber, which is designed to solve these problems. The chamber contains a series of grids by which it is possible to decrease the ionization volume and therefore extrapolate to zero volume. The detailed operation and construction of the chamber are adequately described.

Two photographs; 1 diagram; 2 graphs.
J. DURLACHER, M.D.
Indiana University

Radiological Use of High Energy Deuterons and Alpha Particles. Cornelius A. Tobias, Hal O. Anger, and John H. Lawrence. Am. J. Roentgenol. **67**: 1–27, January 1952.

The Berkeley 184-inch cyclotron produces 190-mev deuterons, 380-mev alpha particles, and 340-mev protons. The particles are accelerated and emerge as a well collimated, approximately monoenergetic beam. The average deuteron beam approximates a soft-tissue dose rate of 1,200 rep per minute. The alpha particle beam intensity is lower by a factor of about ten.

The physical properties of 190-mev deuterons are

discussed in regard to ionization, dose distribution, maximum available depth dose, etc. Isodose curves are presented which show the deuteron beam to have a sharp high peak of ionization and very rapid drop of dosage as it nears the end of its range. Scattering is minimal, as is the exit dose. A radioautograph of the beam after passing through 17.5 gm./cm.^{2} of aluminum is shown, indicating clear definition of beam with marked absence of excessive scattering.

The ratio of depth dose to surface dose may be increased 100-fold by multiple port irradiation, rotational irradiation, and beam focusing. It is felt that the roentgen is not a convenient unit for high-energy beams and the authors suggest six different units of dose, any of which they feel to be satisfactory in interpreting the biological effects.

Measurements of the stopping power and rate of energy loss of the deuteron beam are also considered. Lethal experiments on white mice with high-energy deuterons indicate that qualitatively and quantitatively the biological effect is quite similar to that of 200-kv. roentgen rays.

For studies of radiation effects on mouse tumors, Strong A-strain mice carrying a transplantable mammary carcinoma which is 100 per cent fatal were used. The specific rate of energy transfer was about 2.5×10^4 ergs/g. per minute and each mouse received treatment of only three or four minutes duration. Two separate experiments were performed. In each of these, 20 mice were irradiated and 20 tumor-bearing control mice passed through the same handling but received no irradiation. The specific energy transfer was 9×10^5 ergs/g. at the site of the tumor in the first experiment, and 11×10^5 ergs/g. in the second experiment. The beam aperture was adjusted to fit the size of the tumors of the individual mice.

The effect on the irradiated mice in each instance was quite uniform. Tumor tissues exposed to the most ionizing portions of the beam exhibited rapid regression, in some instances quite complete ten days after irradiation, leaving only scar tissue. Altogether 9 animals out 40 treated survived at least six months after irradiation and their tumors completely regressed. These results suggest the possible application of the deuteron beam to radiotherapy.

Eighteen illustrations; 4 tables.

J. DURLACHER, M.D.
Indiana University

RADIOISOTOPES

A Critical Analysis of the Quantitative I^{131} Therapy of Thyrotoxicosis. A. Stone Freedberg, George S. Kurland, David L. Chamovitz, and Alvin L. Ureles. J. Clin. Endocrinol. & Metab. **12**: 86–111, January 1952.

The investigation described here was undertaken to ascertain (1) whether the thyroid uptake and turnover (biologic half-life) following a therapeutic dose of I^{131} were predictable from the uptake and turnover following a tracer dose, and (2) to determine the relationship between the estimated radiation delivered by the therapeutic dose of I^{131} and the therapeutic effect. The method for measurement of thyroid uptake and turnover by external counting utilized four Geiger-Müller tubes connected in a parallel electrical circuit and arranged in a circle of 45 cm. radius in a horizontal plane about the neck. This method is believed to provide quantitative measurement of I^{131} thyroid gland content, virtually independent of the size and location of the thyroid gland.

In 53 comparisons of tracer and therapeutic doses in 42 patients with thyrotoxicosis, the average uptake of the tracer dose twenty-four hours after administration was 72.7 per cent (S.E., 1.8 per cent) and the average uptake of the therapeutic dose was 72.4 per cent (S.E., 2.4 per cent). The average difference between the twenty-four-hour uptake measured after a therapeutic dose and that measured after the tracer dose in the same patient was 8.6 per cent (S.E., 1.7 per cent).

In 5 of the 53 comparisons, the uptake of the therapeutic dose differed from that of the tracer dose by 20 per cent or more. In 4 of these 5 instances the probable source of the discrepancy was either the recent omission or the administration of stable iodide (potassium iodide and organic iodo compounds) or of antithyroid drugs between the tracer and therapeutic doses.

The average biologic half-life following the tracer dose was 5.5 days (S.E., 1.7) and following the therapeutic dose, 5.5 days (S.E., 1.5). The average difference between the biologic half-life measured after the therapeutic dose and that found after the tracer dose in the same patient was 11.5 per cent (S.E., 1.4 per cent).

In 11 instances in 10 patients the difference between the biologic half-life of a therapeutic dose and that of its corresponding tracer dose was 20 per cent or greater. In 8 of the 11 the biologic half-life of the therapeutic dose was shorter than that of the corresponding tracer dose; in the remaining 3 it was longer. In 1 case, the difference was due to the administration of Diodrast between the tracer and therapeutic dose; no adequate explanation is available for the differences observed in the other cases.

The predictability of the delivered thyroid radiation of a therapeutic dose, on the basis of the uptake and biologic half-life following a tracer dose, was found to be sufficiently accurate to allow for calculated I^{131} dosage. In 50 comparisons made in 40 patients the rep delivered by the therapeutic dose to the thyroid gland differed from that anticipated on the basis of the tracer studies by an average of 16.8 per cent (S.E., 1.8 per cent).

Evaluation of the relationship between delivered radiation and therapeutic effect was possible in 36 of the 42 patients. Twenty-six of the 36 patients received only one therapeutic dose of I^{131} ranging from 2.7 to 25.0 millicuries; 20 patients were euthyroid after an estimated thyroid radiation of 5,800 to 17,000 rep (average, 9,700). The remaining 6 patients receiving one dose became hypometabolic after a thyroid radiation of 8,000 to 19,100 rep (average, 10,900); 5 of the 6 received less than 10,000 rep. There was considerable overlap of dosage in these two groups.

Ten of the 36 patients, though improved, remained thyrotoxic after an initial thyroid radiation ranging from 5,000 to 12,500 rep (average 8,800). Five of the 10 were rendered euthyroid with a total radiation of 11,300 to 37,500 rep delivered in two to four doses totaling 5.6 to 38.0 millicuries. Two became hypothyroid after a total dosage of 17,000 to 19,300 rep

delivered by two doses totaling 12.3 and 5.3 millicuries. One patient remained persistently mildly thyrotoxic after three doses of I^{131} totaling 28.1 millicuries, estimated to have delivered 32,800 rep. Thus, of the 34 patients in whom comparison of total thyroid radiation and therapeutic effect was possible, 25 (73 per cent) are euthyroid, 8 hypothyroid, and 1 presents persistent mild thyrotoxicosis. The greatest incidence of hypothyroidism and a high incidence of persistent thyrotoxicosis were observed in those patients whose glands were estimated to be two to three times (50–75 grams) normal size. The incidence of persistent thyrotoxicosis or myxedema after administration of I^{131} was least in patients whose thyroid glands were estimated to weigh less than 50 grams.

Five graphs; 3 tables.

Estimation of Dosage for Intravenously Administered P^{32}. Calculation Based on Two Compartment Distribution of the Isotope. Bertram V. A. Low-Beer, Robert S. Blais, and Norman E. Scofield. Am. J. Roentgenol. **67**: 28–41, January 1952.

Part I of this article points out that P^{32} is not uniformly distributed in the body tissues, the concentration in bone, spleen, and liver being from six to ten times greater than in muscle, fat, or skin. This necessitates a method of estimating dosage from P^{32} which takes into account the variation between these two main groups of tissues. The treatment records prepared by the authors group bone, spleen, and liver under "bone dose" and muscle, fat, and skin under "soft-tissue dose." This two-compartment distribution of P^{32} does not occur immediately after its administration. Experimental evidence seems to justify the assumption that after a three-day "equilibration" period the concentration ratio between the "bone" compartment and "soft-tissue" compartment is 10:1. Taking into account the concentration changes in the first three days, this results in a "bone" to "soft-tissue" dose ratio of 9:1.

The dose is generally fractionated so that the total dose is built up gradually. Dose is measured in gram-roentgens and consequently the weight of the patient is important in dose calculations.

In Part II of their paper, the authors illustrate the charting of treatments and the use of dose record forms. Different forms are used for patients in different weight groups and correction factors are applied for weight variations within each group. Several examples are given of the method of applying the tables and charts.

Part III is devoted to the derivation of formulae that are employed in dosage calculation.

Seven charts; 5 graphs; 3 tables.

J. DURLACHER, M.D.
Indiana University

The Metabolism of Radioactive Iodine (I^{131}) in Patients with Cardiac Disease. F. Ross Birkhill, K. E. Corrigan, and H. S. Hayden. Am. J. Roentgenol. **67**: 42–50, January 1952.

An investigation was instituted in an attempt to determine alterations in I^{131} metabolism resulting from varying degrees of cardiac failure. Patients in marked and potential decompensation were compared with control groups of normal, hyperthyroid, and hypothyroid subjects following administration of 50-microcurie tracer doses of I^{131}. Counts were made over the thyroid gland, liver, and thigh at intervals beginning two hours after I^{131} ingestion, for thirty to thirty-six hours. Percentages of I^{131} excretion in the urine were determined over the same time interval.

In general, the results were as follows: (1) In the control group I^{131} was cleared from the peripheral tissues in twenty-six to thirty-four hours. (2) I^{131} retention was significantly prolonged in liver and thigh in the patients with cardiac failure. (3) I^{131} cleared the thigh tissues more rapidly but was retained in the liver at a relatively constant level in hyperthyroid subjects up to the end of thirty-four hours. The latter phenomenon may results from protein-bound iodine storage in the liver. (4) Cardiac patients likewise showed a marked decrease in uptake of I^{131} by the thyroid gland as compared with normal subjects, though the urinary excretion of I^{131} varied from 1 to 60 per cent of the dose at the end of thirty hours. (5) In normal subjects excretion of I^{131} reached an insignificant rate after twenty-four hours, but cardiac patients tended to excrete the iodine at a relatively constant rate for as long as fifty hours.

The evidence indicates characteristic abnormalities of I^{131} metabolism in gross cardiac decompensation as well as in cases with borderline cardiac reserve. Tracer studies in these patients may indicate decreased thyroid function, though the reverse may be true. Also in apparently compensated patients showing high peripheral tissue retention of I^{131}, low thyroid uptake, and an abnormal excretion pattern, one must consider the possibility of impending cardiac failure with occult edema.

Six figures.

D. E. VIVIAN, M.D.
Indiana University

Induction of Thyroid Cancer in the Rat by Radioactive Iodine. R. C. Goldberg and I. L. Chaikoff. Arch. Path. **53**: 22–28, January 1952.

In an earlier investigation (Endocrinology **46**: 72, 1950) the authors observed suspicious cytological changes in the thyroid parenchyma of rats killed at various intervals after single injections of I^{131}. In order to evaluate the significance of these changes, a study of the late effects of ionizing radiation emitted by this isotope was undertaken.

At the age of three months 25 rats were given a single intraperitoneal injection of 400μc of I^{131}. Thyroid tumors were found in 9 of the 25 animals when they were killed one and a half to two years later; in 7 of the rats, the tumor was regarded as cancer on the basis of the histologic appearance and the presence of metastases. Benign thyroid adenomata were found in 5 rats, 3 of which also had malignant tumors. Metastases were found in 5 of the 7 rats with cancer. The areas invaded by the metastases were lung, lymph nodes, bone, adrenal gland, and subcutaneous tissue.

The question arose as to whether the thyroid cancers observed were the result of stimulation by increased amounts of thyrotropic hormone released by the anterior pituitary gland. With this in mind, 125 six-week-old rats were placed on a stock diet, to which had been added 0.2 per cent propylthiouracil. These rats were killed after various intervals up to thirty-two months. Their thyroids were tremendously enlarged, but no neoplastic lesions other than adenomata were found. Metastases were not discovered in any of the 24 rats in which adenomata developed.

Three figures; 2 tables.

Production of Experimental Cretinism in Dogs by the Administration of Radioactive Iodine. Curtis A. Smith, Harry A. Oberhelman, Jr., Edward H. Storer, Edward R. Woodward, and Lester R. Dragstedt. Arch. Surg. **63**: 807–820, December 1951.

Cretinism has been produced in a number of different animals by surgical removal of the thyroid gland. Attempts to produce cretinism in dogs have usually failed because of injury or removal of the closely associated parathyroid glands.

This paper reports the complete destruction of the thyroid gland in newborn puppies by the administration of radioactive iodine, with subsequent development of cretinism. The iodine was administered in two ways: (1) to the pups directly at varying times after delivery, with 50 per cent of each litter preserved as a control, and (2) to the mother before delivery, so that all pups in the litter received the I^{131} *in utero*.

Thyroid function was estimated by determination of the conversion ratio of free to protein-bound iodine after the method of Clark.

The actual experimental work is given in some detail. The treated animals showed an impairment of growth and skeletal development, obesity, lethargy, coarse dry skin and hair. They also showed hyperlipemia, hypercholesteremia, and depressed conversion of free to protein-bound iodine.

Associated endocrine changes were immaturity of the gonads and increase in size of the pituitary.

Four roentgenograms; 5 photographs; 4 photomicrographs; 4 graphs.

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Estimates on the Concentration of Radioiodine in Sewage and Sludge from Hospital Wastes. C. C. Ruchhoft and Sergei Feitelberg. Nucleonics **9**: 29–34, December 1951.

Instead of the expected general discussion of the concentration of radioiodine in sewage disposal, as implied by the title, this article is a critique of a previous paper on radioactive waste disposal by K. G. Scott (Nucleonics **6**: 18, 1950), as it affects the University of California Medical Center in San Francisco, showing how fallacious reasoning can produce apparently serious discrepancies from the actual findings.

In view of the concern imparted by Scott's paper, it was considered worth while to examine the amounts of I^{131} and P^{32} distributed to large centers of population in the United States and consider implications of the discharge of such quantities of wastes into domestic sewerage systems. Probably waste disposal in the city of San Francisco is in a better condition than in any of the other five cities from which data were collected: New York, St. Louis, Chicago, Los Angeles, and New Orleans.

It is concluded that the probability seems remote that any one hospital will discharge regularly as much as 200 mc. of waste per day into the sewage of a large city. At this rate, the dilution needed to reduce the activity to safe limits is no major problem.

The discussion on the activated sludge from waste disposal is well worth perusing from a public-health point of view, if from no other.

Two illustrations; 3 tables.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Selective Absorption of Radiophosphorus, Sodium Fluorescein and Atebrin in Tumor Diagnosis. H. Cramer, C. Brilmayer, and H. W. Pabst. Schweiz med. Wchnschr. **82**: 76–78, Jan. 26, 1952. (In German)

The authors base their studies on 1,000 patients to whom they administered radiophosphorus, sodium fluorescein, and Atebrin. They found that sarcomatous and carcinomatous tissues are capable of taking up these compounds.

Following injection of 0.25 c.c. of radiophosphorus, an exchange of the organic and inorganic phosphorus takes place in the tumor tissue. The absorption of the radiophosphorus is measured by a Geiger-Müller counter over the tumor area and the readings are compared with those made in an analogous location. The difference in readings is proportionate to the degree of uptake by the tissues. To consider a case positive, the authors desire at least a 25 per cent difference in readings seven days following the injection.

Only in patients with superficial lesions is an early differential diagnosis possible, inasmuch as the beta ray of radiophosphorus penetrates but 7 to 11 mm. of tissue. Contraindications to the use of radiophosphorus are eczema and mammary and prostatic carcinomas following hormone, roentgen, or radium therapy.

The authors experimented with the intracavitary use of miniature Geiger-Müller counters in patients with tumors of the esophagus, stomach, bronchial tree, and rectum, and the results were encouraging.

The exact localization of tumors is not possible with sodium fluorescein, but their presence may be inferred indirectly, from altered excretion of sodium fluorescein in urine. Sodium fluorescein is absorbed by the tumor tissue; this absorption may be directly visualized in ultraviolet light. Normally, sodium fluorescein is excreted after fifty to seventy hours, but in patients with tumors total excretion may not occur until two hundred hours have elapsed. In one case, two thousand hours were necessary for complete excretion. The excretion is delayed also in edema, tuberculosis and in injuries. This method is not applicable if the urine is positive for bilirubin, urobilin, or urobilinogen.

The examination after Atebrin injection (0.1 gr. iv.) is much simpler. Normally, forty hours after injection the excretion reaches a peak; in tumor cases it can be detected for only three hours.

Four charts.

ILONA D. SCOTT, M.D.
VA Hospital, Chamblee, Ga.

Content of, and Incorporation of P^{32} into, the Nucleic Acids of the Liver, Spleen, and Lymphosarcomatous Tissue of Man. Kingsley M. Stevens. Cancer **5**: 122–125, January 1952.

The nucleic acid content of certain animal tissues has been extensively studied, but the author was able to find only 4 reports for human tissues. The present report represents the first combined study of the uptake of radiophosphorus and the nucleic acid content of human liver, spleen, and lymphosarcoma. The data were obtained in a patient with lymphosarcoma who received several forms of therapy that are known to influence nucleic acid metabolism: roentgen rays, nitrogen mustard, P^{32}, and possibly cortisone.

The content of P^{32} in ribonucleic acid phosphorus (RNAP) and in desoxyribonucleic acid phosphorus (DNAP) and the ratios of their specific activities (S.a.) were as follows:

	Specific Activity Counts/min/mg. P.		S.a. RNAP / S.a. DNAP
	RNAP	DNAP	
Liver	2,105	284	7.42
Spleen	2,490	1,230	2.02
Lymphosarcoma	3,180	2,450	1.30

The amount of RNAP and DNAP and the amount of DNA obtained by direct analysis was:

	Mg. P/gm. fat-free dry weight		RNAP / DNAP	Mg. DNA/gm. fat-free dry weight
	RNAP	DNAP		
Liver	1.83	0.47	3.9	5.6
Spleen	1.16	1.37	0.9	16.5
Lymphosarcoma	3.94	4.40	0.9	51.5

The RNAP:DNAP ratios, both for amounts and activities, were in fairly close agreement with those reported for similar tissues in lower mammals.

Some Factors Affecting the Clearance of Na^{24} from Human Muscle. Lawrence H. Wisham and Rosalyn S. Yalow. Am. Heart J. **43:** 67–76, January 1952.

In 1949 (Am. Heart J. **38:** 321, 1949) Kety reported that the local clearance of radioactive sodium could be used as an indirect measure of effective blood flow. He theorized that the rate of clearance of radiosodium from tissue in man would be proportional to the amount at the site, and therefore a plot of the activity above the injection site as a function of time would be a straight line. Subsequently Franke and his associates (Proc. Soc. Exper. Biol. & Med. **75:** 417, 1950) ran a series of experiments similar to Kety's and found that the clearance slope when plotted was *not* a straight line. The present authors explain how the findings of Kety and Franke are in fact consistent, and also offer a technic for more accurate determination of the clearance of radiosodium from muscle in man.

A series of experiments was conducted in which patients with normal circulation received injections of isotonic sodium chloride solution containing 1 to 3 microcuries of Na^{24} into the (1) skin, (2) subcutaneous tissue, or (3) muscle. A thin, mica-window Geiger counter was used for the clearance determinations in every experiment. It was found that the plotted points of the clearance of radiosodium from the skin and subcutaneous tissues were along a straight line. As plotted from the raw data, the clearance from muscle appeared to be represented by a curved line, but actually such a line represents both subcutaneous and muscle clearance, and the former, because of its slow rate, is of significance. By utilizing the clearance time for subcutaneous tissue on the one hand and the combination of subcutaneous tissue and muscle on the other, a straight line for muscle alone was obtained, proving Kety's original hypothesis.

Four charts; 2 tables. HENRY K. TAYLOR, M.D.
New York, N. Y.

Radioactive Colloidal Gold for the Treatment of Cancer of the Female Reproductive Tract. Alfred I. Sherman, MacDonald Bonebrake, and Willard M. Allen. J. Missouri M. A. **49:** 24–25, January 1952.

This is a brief summary of the technic of injecting radioactive colloidal gold into the parametrial tissue in patients with pelvic cancer. X-ray treatments were omitted. The radioactive gold was injected with a spinal needle into each parametrium through the vagina. The authors state that this method gives rather uniform dispersion of the gold throughout the treated area. In 4 cases gold was also injected directly into the cervix. At various intervals following injections, ranging from two to forty days, radical total hysterectomy and pelvic lymph node dissection was performed. On examination of the tissues, the injected parametrial areas showed definite radiation effects. The lymphatics for the most part were packed full of scavenger cells containing gold particles. Radioactive gold deposits were found in the hypogastric, iliac, and obturator nodes.

Radioactive gold was also used in patients with ovarian cancer and generalized peritoneal involvement, the radioactive gold being injected directly into the ascitic fluid. Although no long-term follow-up of a patient so treated is given, pathologic examination of surgical and autopsy material showed that lymph node metastases within the pelvis received considerable radiation.

The authors state that animal experimentation showed the approximate dose required for cure of carcinoma in this manner to be 300 microcuries per cubic centimeter of tumor tissue. They do not state what doses were used in the patients treated.

PAUL R. NOBLE, M.D.
Pittsburgh, Penna.

A Study of the Use of Radioactive Gallium in Medicine. Frederick R. Lang. Ann. Int. Med. **35:** 1237–1249, December 1951.

Previous experimental studies by Dudley and his co-workers have shown that gallium is an avid bone seeker (see Dudley and Maddox: J. Pharmacol. & Exper. Therap. **96:** 224, 1949). It has been shown also by animal experimentation that lethal and near-lethal injections of gallium salts will produce loss of weight, hyperexcitability, photophobia, blindness, and terminal flaccid paralysis. The doses (in milligrams per kilogram of body weight) required to produce these effects, however, were greatly in excess of those estimated for tracer studies or therapeutic effects on bone tumors in man.

The studies reported here were made with $gallium^{72}$, which, because of its short half-life (14.3 hours) and the type of radiation emitted, seemed the ideal isotope of this metal for human application. This isotope has gamma radiation of 2.53 mev and beta radiation of 2.50 mev. Neither the inert gallium nor the radioactive isotopes of gallium seem to enter into the active metabolism of the body.

For diagnostic or tracer studies, a dose of 350 to 400 microcuries of $gallium^{72}$ is used. For therapeutic use, larger doses are considered necessary. For both purposes the isotope is administered intravenously. By the use of Geiger-Müller counters, it was found that 80 per cent of the administered dose becomes localized within two hours. In normal bone the localization reaches a maximum within one hour. In the malignant

bone lesions thus far studied, the maximal localization in the diseased areas is reached within ten hours.

The author reports on a total of 12 patients having various types of malignant bone tumors who had been given radioactive gallium^{72}. These patients were selected primarily from those with proved malignant lesions and with x-ray evidence of osteoblastic or osteolytic metastases. In 6 patients the primary tumor was a carcinoma of the prostate; in 2, carcinoma of the breast; in 1 each, bronchogenic carcinoma, gastric carcinoma, osteogenic sarcoma, and osteochondrosarcoma. In each instance, tracer studies revealed a significantly increased pick-up of radioactivity over every metastasis demonstrated by x-ray survey of the bones, due to the higher deposition of radioactive gallium in the metastases than in normal bone. On several occasions, areas of bone were found which emitted increased irradiation after the administration of radioactive gallium and in which no x-ray evidence of metastases could be found. It is believed that these were undoubtedly areas in which metastases were forming at a stage too early to be demonstrated roentgenographically.

Studies on the use of radioactive gallium in man show a complete agreement with the results of animal experimentation. No evidence of toxicity or any untoward effects was observed. The short-life of this isotope makes control of the radiation dosage much easier and reduces the possibility of prolonged harmful residual radiation effects. Due to its selective location in desired bony structures, these therapeutic advantages over other materials warrant further investigation.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Radioisotope Hazards and Protection in a Hospital. Marshall Brucer. J. A. M. A. **147:** 1745–1751, Dec. 29, 1951.

A year of experience in the Medical Division of the Oak Ridge Institute of Nuclear Studies, in which some 18 different isotopes have been employed in a wide range of doses, serves as a basis for discussion of contamination and protection problems to be encountered in the use of isotopes in small hospitals.

In accord with the recommendations of the Chalk River Conference (September 1949), later substantiated by the International Commission on Radiological Protection (London, 1950), the maximum permissible dose of radioactivity in the critical tissue (bone marrow) is 0.3 rep per week (6.25 milliroentgens per hour).

The nurses at the Institute are provided with a portable Geiger-Müller type of monitor, for determination of the amount of radioactivity following administration of a radioactive isotope. Depending on the readings, one of three sets of restrictions is employed. These consist of regulation of visitors, limitation of working hours spent near the patient, and restrictions as to the handling of sample collections of urine, feces, and blood and linens.

The safe distance from the patient is established by determining the points at which the radiation in the air measures 6.25 milliroentgens per hour. This decreases more rapidly with the short-half-life isotopes. With isotopes of high-energy emission, such as gallium, ordinary walls afford no protection, so that adjacent rooms and halls must be monitored. Shielding can be accomplished by dense concrete walls, marble slabs, or armor plate 2 inches thick mounted on casters.

Film badges and pocket chambers are worn by personnel and checked weekly by the health physicist. Selected personnel wear direct-reading pocket dosimeters. In a three-month study, a staff chemist processing samples of radiogallum, as they came from the reactor, and his technician assistant received the largest exposures. Orderlies caring for the patients and technicians handling urine, feces, blood, and tissue samples received the next largest routine doses. All were less than the maximum permissible exposure, however, and did not exceed the exposure received by personnel in a busy diagnostic x-ray service in a nearby medical school. Hazardous doses were received by surgeons during operations on patients treated with radioactive substances (for example, 400 milliroentgens on the surgeons' hands and 40 milliroentgens total-body exposure to the anesthetist in an operation of two and a half hours to remove the lung of a patient who had been given a test dose of 20 mc. Ga^{72}). Such operations, however, are infrequent and the risk is believed to be no greater than in interstitial radium implantation, in holding patients during diagnostic roentgenology, etc.

If radioisotopes are injected *via* an unprotected syringe more than once or twice a week, the exposure to the operator is excessive. A lead-shielded syringe is described in detail. A shielded intravenous infusion apparatus with distance control is also described.

Standard lead bricks are advised for laboratory shielding. For less intense shielding, marble or soapstone may be used. Soapstone has the advantage of easier decontamination than lead or stainless steel, being easily cleaned with ordinary emery paper.

Six illustrations; 3 tables. OWEN MARTIN, M.D.
University of Michigan

RADIATION EFFECTS; PROTECTION

Radiation Sickness: A Clinical Investigation. Frank Ellis and Basil A. Stoll. J. Fac. Radiologists **3:** 207–222, January 1952.

The authors report the results of treating 225 cases of radiation sickness in the Radiotherapy Department of the London Hospital from May 1948 to May 1950. No case was included in the series unless the patient experienced vomiting and severe nausea, with or without other symptoms. Radiation sickness occurred in 7 to 8 per cent of all cases receiving deep x-ray therapy, being seen predominantly following the "abdominal bath" technic and lumbar region irradiation.

The drugs chosen for treatment were Benadryl Benzedrine, Pyridoxine hydrochloride, dilute hydrochloric acid, and a combination of Pyridoxine and hydrochloric acid. As a control, lactose tablets were used in a series of 60 cases. Of the drugs employed, all have been reported upon favorably by at least one investigator. Only the combination of Pyridoxine and hydrochloric acid was new.

The authors analyze their observations in detail and conclude that whatever the drug used, vomiting is the easiest to relieve of all radiation sickness symptoms, and nausea somewhat less so. On the basis of their effectiveness, Benzedrine and Benadryl, together with the inert lactose tablets, are classified as "less active,"

and Pyridoxine and hydrochloric acid alone or in combination as "more active." Any of the drugs will give some relief of vomiting and nausea, but the advantage of the more active group is shown in the proportion of patients experiencing complete relief of anorexia and listlessness. In this respect the combination of Pyridoxine and hydrochloric acid proved most efficacious.

A significant finding was that inert tablets give a surprisingly high proportion of relief of symptoms, *i.e.*, in 19 to 29 per cent complete relief compared with 46 to 60 per cent for the best drug combination. There was no difference in the palliation by any individual drug of the whole group of symptoms arising from irradiation above or below the diaphragm. The less active group of tablets, however, gave just as good relief as the more active group in vomiting arising from irradiation of the upper half of the trunk and similarly in symptoms due to irradiation of the head and neck. In all other groups the less active drugs were inferior.

Thirteen graphs; 2 tables.

WILLIAM H. SMITH, M.D.
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Pneumonectomy for Severe Irradiation Damage of the Lung. Martin Bergmann and Evarts A. Graham. J. Thoracic Surg. **22:** 549–565, December 1951.

Patients with severe irradiation damage to the lung are incapacitated and miserable from intractable cough and dyspnea. There is a marked reduction in maximum breathing capacity, and with exercise marked hyperventilation occurs. Tests reveal normal blood chemical conditions. The cause of the hyperventilation, dyspnea, and cough appears to be in abnormal reflexes originating in the altered lung. Hence, the logical treatment of unilateral radiation damage would seem to be pneumonectomy. This procedure was employed on two patients, with noteworthy relief.

Study of the resected lungs failed to reveal the hyaline membranes found consistently in autopsy specimens and previously considered diagnostic of radiation damage. Such hyaline membranes are not seen in experimental animals subjected to irradiation, and the authors believe they represent an agonal artefact. The presence of an increased number of thick elastic fibers diffusely throughout the irradiated lung appears to be an important criterion for the histologic diagnosis of irradiation damage.

Patients with mild degrees of irradiation damage may present slight symptoms and changes. Unless the syndrome of irradiation damage to the lung is kept in mind, an erroneous diagnosis of pulmonary metastatic carcinoma may be made under these circumstances and further irradiation might be administered, with serious results.

Two roentgenograms; 9 photomicrographs.

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Protection Against X-Ray and Beta Radiation. Lead Glass Fabric. Vincent W. Archer, George Cooper, Jr., J. G. Kroll, and D. A. Cunningham. J. A. M. A. **148:** 106–108, Jan. 12, 1952.

Working on the basis that the hazard of leukemia is higher in those specializing in radiology than in the general population, the authors sought a suitable means of providing these persons with more adequate protection against radiation. It was concluded that a garment of spun lead glass fabric covering the usually unprotected areas of the body as well as those usually covered was most suitable for protection, especially during fluoroscopy. The quality of radiation and amount received at various parts of the body during fluoroscopy were established under actual working conditions and requirements for protection were determined. Then, the fact having been established that one thickness of this fabric was equivalent to 0.035 mm. of sheet lead, a gown was constructed to meet requirements. This gown offers such advantages as adequate protection to all portions of the body without an increase in weight over that of the apron in present use. Also, there is a more even weight distribution and greater flexibility, durability, and cleanability of the garment. In addition, the advantageous properties of this fabric allow it to be used in many ways as a protective screen against radiation.

Six illustrations.

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Systemic Enzyme Changes Induced by Radiation Therapy of Malignant Tumours. Philip M. West. Brit. J. Radiol. **25:** 44–47, January 1952.

Two proteolytic enzyme inhibitors in the blood serum, anti-chymotrypsin and anti-rennin, were found to be present in abnormal amounts in patients suffering from cancer. After irradiation the amounts changed more or less toward normal, depending upon the response of the tumor to the treatment. From this some indication of the prognosis can be obtained.

In normal adults the anti-rennin exceeds anti-chymotrypsin, the maximum values being 12 and 5 units, respectively. Rapidly growing cancer causes a reversal in this ratio. In patients in whom cancer is undergoing regression or is arrested, the chymotrypsin inhibitor is within normal range and the anti-rennin is greatly elevated.

Similar changes are found after treatment with nitrogen mustard. In some instances this allows a comparison of that type of therapy and irradiation, and also indicates the probable duration of effectiveness.

Several illustrative cases are cited.

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Effect of Aureomycin on the Radiation Syndrome in Dogs. F. W. Furth, M. P. Coulter, and J. W. Howland. Am. J. Path. **28:** 25–36, January–February 1952.

This report concerns observations made on a group of dogs exposed to whole-body x-irradiation and then treated by a single antibiotic, Aureomycin.

Immediately following 450 r whole-body irradiation, 12 dogs were given Aureomycin, and this medication was continued every six hours, day and night, for twenty-eight days (approximately 100 mg. of Aureomycin per kg. per twenty-four hours). Twelve similarly irradiated dogs served as controls. The radiation factors were: 250 kv.; 15 ma.; parabolic aluminum filter with 0.5 mm. copper; target-skin distance 40 inches; rate 7.15 r per minute.

Identical alterations in blood cell counts and coagulation mechanisms were observed in both groups. Bacteriologic studies on blood and feces are reported separately (see following abstract). Organisms recovered from cultures of necropsy material from the

control dogs were sensitive to Aureomycin, while those from the treated dogs were resistant.

Gross necropsy findings disclosed no gastrointestinal ulceration and minimal evidence of hemorrhage in the treated group, while severe gastrointestinal ulcerations and hemorrhage were found in the control dogs.

The total mortality was 58 per cent in the control group and 44 per cent in the treated group. The first death in the control group occurred seven days before the first death in the treated group. A similar delay in the onset of clinical signs of radiation sickness was noted.

It is postulated that the observed changes are related to the control of the infection and infectious processes by Aureomycin.

Bacteriologic Studies of the X-Radiated Dog. F. W. Furth, M. P. Coulter, and J. W. Howland. Am. J. Path. **28:** 171–183, March–April 1952.

In an earlier paper the authors reported their clinical and pathological observations on a group of dogs exposed to 450 r whole-body x-irradiation and then treated by the antibiotic, Aureomycin (see preceding abstract). They now describe the bacteriologic findings.

Bacteriologic studies were made of the blood, necropsy material, and feces of both the irradiated and normal dogs.

The percentage of positive blood cultures in the control group increased following irradiation and exceeded the number of positive cultures in the treated group following irradiation. Of all the positive anaerobic cultures post-irradiation, 12 showed gram-positive bacilli of the Clostridia group, 3 gram-negative bacilli, and 11 gram-positive cocci. The incidence of positive blood cultures was no higher in the dogs that died.

The fecal coliform bacteria, staphylococci, and streptococci increased to a greater extent post-irradiation in the Aureomycin-treated dogs than in the controls. An increase in fecal bacterial count following the administration of Aureomycin, however, has been observed by other workers. A secondary increase in fecal coliform count is attributed to the fact that these organisms became resistant to Aureomycin after seven days of administration.

The view that the bacterial flora of the bowel is an important source of infection to the irradiated animal was substantiated by the isolation from necropsy material of bacteria which are the normal inhabitants of the intestinal tract. Basic factors contributing to the spread of enteric infection to other parts of the body of the irradiated animal are damaged capillaries and ulcerations of the intestinal mucosa, damage of the reticulo-endothelial barriers, destruction of mesenteric lymph nodes, and leukopenia. The increased number of coliform bacteria and staphylococci in the bowel of the irradiated dogs may be of significance in the radiation syndrome.

Four charts; 4 tables.

Effect of Aureomycin and Terramycin on the X-Radiated Rat. F. W. Furth, M. P. Coulter, and J. W. Howland. Am. J. Path. **28:** 185–191, March–April 1952.

In a continuation of their investigation of the effect of antibiotics on the radiation syndrome described in the two preceding abstracts, the authors treated 119 irradiated rats with Aureomycin and 75 with Terramycin. An equal number of irradiated rats served as controls. The radiation factors were: 250 kv.; 15 ma.; parabolic aluminum filter with 0.5 mm. Cu; target-skin distance 40 inches; total target-skin dose 700 r, administered at the rate of 16 r per minute. The drugs were given orally for a twenty-eight-day period post-irradiation. The average twenty-four-hour dose was between 80 and 100 mg. per kg.

The most striking effect of the administration of Aureomycin and Terramycin to the irradiated rat was a decrease in incidence of diarrhea. Not over 23 per cent of the rats in the treated groups had diarrhea on any day following irradiation in contrast to 60 per cent of the control rats.

Following irradiation, an equal weight loss occurred in all groups. After this period the surviving antibiotic-treated rats began to regain weight at a much more rapid rate than the control animals, and continued to do so during the period of observation. There was no significant difference between the Terramycin-treated and Aureomycin-treated rats in this respect.

The rate at which the animals in the Aureomycin-treated group died paralleled the mortality rate of the control group, with no significant difference in the twenty-eight-day mortality. The mortality rate and twenty-eight-day mortality of the Terramycin-treated group appeared to be significantly lower than that of the controls.

Five graphs.

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